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Alternating Current Motor Controversies. THE lively battle in regard to claims for priority in the invention of different forms of alternating current motors or of details connected with them, which has been waging for some time in our columns, is continued in the present issue. As the subject is an important one, and the discussion likely to bring out points of interest to the general electrical public, the warfare assumes a useful character aside from the question directly in dispute. We trust, however, that the controversy will be conducted on a dignified scientific basis, and not descend to the personalities and unsupported recriminations that so frequently mar otherwise valuable discussions.

Nautical Electrical Displays. THE magnificent electrical displays given by the British fleet during its stay in the North River added very much in a popular way to the prestige of the British navy, and, by comparison, correspondingly detracted from that of our own. It is hoped that on future occasions our ships will not again permit themselves to be thus outrivaled, but of this we feel sure there need be no fear. The exhibition brought out the great possibilities afforded by the electric light for brilliant displays on the water. The great beauty of the sight of majestic ships dressed with rows of brilliant lights artistically disposed was universally commented upon, and the public will doubtless hereafter expect such decorations as an appropriate part of naval displays on similar occasions.

New Incandescent Lamps. A GOOD result of the decision of last fall, which tended to establish a monopoly of the incandescent lamp industry, has been to turn inventors' minds toward devising lamps that would evade the patent then apparently so definitely sustained. We have described a large number of these new lamps in our columns recently, many of which display novel features and some promising to outrival the ordinary type. The stoppered lamp seems to be the favorite one experimented with, but not less important has been the attempt to invent a gas lamp, and in this the prospects for success are claimed to be bright, there being two types now on the market. The claim for one of these, that there is no decrease in the candle power during the natural life of the lamp, is an important one, and it is hoped that in actual commercial use it may be fully sustained, and thus a serious defect done away with. Another inventor claims to have perfected a filament that, on account of the high incandescence at which it may be used, enables a saving of sixty per cent. to be made. It will be indeed surprising if the thorough overhauling the question of incandescent lamps has recently undergone does not result in considerable or even startling advances. Perhaps, after all, the lamp decision of last fall was a blessing in disguise.

Electrical and Insurance Interests. IN a recent issue we had occasion to comment on the favorable views held toward electrical interests by insurance officials who had a knowledge of the electrical principles concerned. In the present issue we print an abstract of a recent address by Mr. James A. Waterworth, president of the St. Louis Board of Fire Underwriters, in which the same spirit before noted is manifested, and of which the amicable relations that exist in that city between the electrical and insurance interests are no doubt a direct result. Mr. Waterworth very clearly shows that while two interests may be naturally antagonistic yet the policy is suicidal that prevents either from regarding the interests of the other when they clash. The conclusion that inspection should be left to the insurance organizations seems to be wise. Any other system that can be imagined would appear to lack the two great essentials—that of the selection of inspectors for competency alone, and the spur to efficiency from the direct money interests at stake. It is greatly to be feared that the "electrical expert" described is still in existence in too many localities, particularly where the visits of the insurance inspector are few and far between. It is difficult to see how he can be entirely eradicated, as an inspector cannot be resident in every town in which the electric light is used, and it is rather too much to require that work shall not be closed in until after one arrives, perhaps after considerable delay, and at a great expense besides, for a single inspection.

General Electric in Wall Street. THE severe drubbing that the General Electric Company received in Wall street last week was probably not so much on account of its own shortcomings as through those of the other industrial concerns with which it was unfortunately classed. The weak state of the money market, due to a number of causes that have been gathering force during a considerable period, culminated in a panic on Friday through the collapse of the National Cordage Company, and in the great scare the General Electric stock suffered severely in common with a number of other industrial securities. For some time this class of stocks has been viewed with suspicion on account of inflated values, but probably the General Electric would not have been much affected by the panic if it had not been for a lack of confidence previously brought about by severe criticisms of the recent annual statement of the company and by the Hallett lamp decision. That the reverse was not serious was shown by the manner in which the stock rallied, and the profitable business of the company and the continuously expanding electrical market furnish a reliable basis that in the end will no doubt tend to reestablish general confidence. A lesson that the shaking up will doubtless teach is that there is a decided limit to the species of financiering which the General Electric Company has recently undergone, and that a frank statement, with perhaps a smaller showing, may after all be better than a too favorable showing that challenges attack. The opinion seems to prevail that before the General Electric can again attain unquestionable standing a detailed statement will have to be made in regard to the stocks and bonds of local companies valued at over nine million dollars which it now holds among its assets.

The Electrical Fountains. IN our issue for Jan. 21 we published certainly the fullest popular description of electrical fountains that has ever appeared in an electrical journal, in which considerable space was devoted to a description of the proposed fountains at the World's Fair. The article was profusely illustrated and would have attracted attention anywhere through its intrinsic merit. As the publication at that time interfered with the well matured plans of one of our contemporaries, that journal attempted to discredit the article and the cuts by an editorial statement that both were wrong and therefore worthless. In a recent issue of that same journal there appeared a well written article on the same subject, and it was with the keenest anticipations that we settled ourselves in our easy chair for its perusal. We expected to find the subject handled, now that they were ready to treat it, in an admirable manner, and in this we were not disappointed. But the past two or three weeks have demonstrated pretty conclusively that an event cannot be described quite so accurately at a distance of 900 or 1,000 miles, however talented the writer, as it can be by those who are on the ground, and have been eye witnesses of the thing described. We were not surprised, therefore, that a few inaccuracies found their way into the article in question, and lest our readers who may also have seen that article may be misled we will undertake here to point out some of them. In the first place, the alleged view of the fountains casts a serious doubt on the compliment implied by the credit given to those upon whose shoulders the responsibility of their designs rests. Next, in many of the purely electrical data the author is widely astray. The mechanical features of the construction of the great caissons, of the sheet piling and the support for the roof are handled in a manner beyond criticism, but when he comes to the discussion of such trivial matters as the arc lamps or "holophotes," or signals, or valves he seems to have been a trifle careless. To specify more clearly, he states that to each electric fountain runs a 24-inch main when it should be a 16-inch main. "*Two direct* connected generators" is the way the generating plant is tersely described. This is admirable, but the laconic story is spoiled by the troublesome fact that there are *four* instead of two and these are all *belted* to their engines as described elsewhere in this issue. There are two of the kind described that may be used when desired, but they are not, as we understand it, the special generators for the fountains. The arc lamps, or rather "holophotes," are described as using "no less than 90 ampères each," whereas those installed are wound for but 80 ampères, nor are these lamps "carried on standards or bases placed on the floor of the caisson," but on heavy pine tables. In "the silvered reflector is 28 inches diameter," read "22 inches" if you wish to be correct. The statement that "the valve mechanism is also concentrated at the switchboards in each fountain, and hence it is easy for one or two men to manipulate switches, valves and revolving color screens," raises a doubt in our mind, since there is but one switchboard, and the valves are from 15 to 25 feet away, and the color screen control devices some 50 feet distant; thus these devices are "concentrated," in the sense in which Dundreary's bird "flocked." The ceiling of the chambers is something over eight feet high, so we will not question the statement that they "are high enough to enable the attendants to move around easily in an upright position." In describing the signaling apparatus placed in the northeast tower of Machinery Hall, he says: "The numbered boxes show when any jet is in operation, and the light that burns while it is playing shines through glass corresponding to that on the fountains." We interpret this to mean that if the operator or any one else doesn't know which jet is playing or its color, he can climb up into the tower and by looking at the signal box find out. The engineering drawings, the sections, etc., are fine, but since the present fountains are not built in conformity with these drawings, we fear our friend got hold of the wrong set, or perhaps this is the article with which our untimely publication in January last interfered. But our friend is at his best in flights of rhetoric, and we cannot close without giving him the credit deserved. He outdoes himself here, and at one point reaches the sublime. He says: "A *thrill* that lasts half an hour without an intermittent *throb* or pause would probably become overwhelming, and these stupendous spectacular effects are in the nature of *sensations* or *thrills*. The Paris fountains of 1889 lasted four minutes at a time, and were played hourly." That is, at Paris he thrilled for four minutes and then throbbed for an hour. . . . We laid down this brochure in pretty much the same frame of mind as we have gotten up from seeing Booth in "Richard III"—thrilled but tired.

Sensational Charges Against the General Electric Company.

On Friday last Morris W. Mead, chief of the Bureau of Electricity in Pittsburgh and an electrician of the World's Fair, Frank Carey and Joseph Butler were arrested on a charge of conspiracy preferred by A. S. Carpenter, counsel for the Westinghouse company. Carey, who was an assistant draughtsman, formerly employed in the Pittsburgh office of the General Electric Company, and Butler, who was the night watchman there and had the custody of the keys of the draughting room, were jointly charged with opening the gates to the enemy. Mead was released on bail, but Carey and Butler were sent to jail pending examination. The former is well known all over the country and denies any connection with the General Electric Company.

Charges on the same grounds were also preferred against President Charles A. Coffin, of the General Electric Company; William J. Clarke, manager of the railroad department; Milton H. Hamilton, Mr. Clarke's private secretary, and E. N. Rice and Walter H. Knight, electricians in the company's employ.

In Boston a bill in equity against the General Electric Company in its corporate capacity, and also against several of the officers of the company individually, was filed on Saturday by Warren & Brandeis, of Boston, counsel for the Westinghouse company. The bill alleges that the defendants have in their possession certain plans relating to electrical devices which have been wrongfully obtained from the plaintiff company, and asks that the defendants be ordered to produce them and deliver them to the plaintiff.

In their complaint the officers of the Westinghouse company allege that the General Electric Company, through the bribery and corruption of certain employés of the plaintiffs, had obtained possession of plans, specifications, blue prints and a mass of confidential information, relating directly to the plans submitted by the Westinghouse people to the Cataract Construction Company.

After the arrests in Pittsburgh, the Westinghouse Company's local manager there gave out the following statement: "For some months the officials of the Westinghouse Electric and Manufacturing Company have been suspecting that in some way its great rival, the General Electric Company, was providing itself with blue prints of the drawings and plans of the latest apparatus and inventions of the Westinghouse Company, copies of proposals and prices which the Westinghouse Company was making upon work in competition with the General Electric Company, the cost of apparatus and other confidential information. It is declared that as far back as July last an arrangement was made under the direction of Mr. Coffin, president of the General Electric Company, with the assistance of his right hand man, William J. Clarke, by which a certain young man entered the employ of the Westinghouse company as a draughtsman at the works in Pittsburgh, for the very purpose of getting into the secrets of the company, for the benefit of the General Electric Company. Besides receiving a salary from the Westinghouse company, he is averred to have received a much larger salary from the General Electric Company, and a liberal fund, by means of which he was placed in a position to be regularly furnished with blue prints and other information secured from the offices and works of the Westinghouse company. Several hundred blue prints and drawings, including almost all of the improved new designs of the Westinghouse engineers, and copies of a great many incidental papers, were in this way furnished to the Westinghouse company's rival—frequently so promptly that the General Electric Company could utilize the designs of the Westinghouse engineers almost as promptly as the Westinghouse company itself. At this point quite a large number of missing blue prints were located at the Lynn factory of the General Electric Company and the Westinghouse Company served upon the General Electric Company, the Thomson-Houston company and several of their officials, a notice to the effect that all the Westinghouse blue prints described in the replevin previously served were stolen property, and that in case they were not promptly returned to the Westinghouse company, further proceedings would be taken.

George Westinghouse, Jr., has made the following statement:

"The action which has been taken was an absolute necessity, in view of the great injury being worked to the company by the conspiracy. But the matter is now in the hands of the officers of the commonwealth, and must rest there, so that there is nothing which the company can properly say."

It is said that on last Tuesday certain papers were located on the premises of the General Electric Company. They consisted in part, it is alleged, of numerous blue prints of the Cataract Construction Company, of Niagara Falls, of plans numbered 4 and 5 of the Street Railway Generator Company, and other documents relating to Westinghouse interests in Providence, Chicago and New Haven.

On Thursday papers were given to Deputy Sheriff Cronan, of Lynn, by order of the court, to make a search of the General Electric premises for these papers. The officer made a demand on Chief Engineer Knight for the documents. Knight, it is said, admitted that there were a large number of blue prints there, and gave the officer some of them.

In regard to the accusation made by the Westinghouse company that its rival, the General Electric Company, had withdrawn its original plans and proposals and had submitted a new set, almost a duplicate of the Westinghouse company's, to the Cataract Construction Company, Mr. Stetson stated that the "Cataract Construction Company received competitive plans for the power plant of the Niagara Falls Power Company from both the Westinghouse and the General Electric companies, after having received others from several European companies. The resemblance between the plans of the two American companies is not as close as that between those of the foreign companies. No competitor's plan has been permitted to be seen by any other competitor, and I do not for a moment believe that either competitor has stolen the plan of any other. There is no mystery in the preparation of such plans, nor anything beyond the power of any highly skilled mechanical engineer dealing with problems of applied electricity. The conditions being the same, similar devices and systems would naturally be designed and furnished by competent engineers, such as are employed by both the Westinghouse and General Electric companies. The Westinghouse company's plan has great though not exclusive merit, and the idea of piracy is foreign and unnecessary to the honorable competition for the work at Niagara Falls. The Cataract company has not yet made a selection between the competitors, but in reaching a conclusion it will in no manner be influenced by this 'aliunde' discussion. I believe that either of these companies is perfectly competent and equipped to do the work, and that neither needs to ask any favors of the other."

The officials of the General Electric Company deny all knowledge of the conspiracy and thefts. One of the officials frankly admitted, however, that it is not only possible but probable that they possess some technical matter that originated with the Westinghouse company, but which has come into their possession through the usual channels that such matter reaches competitors in all branches of business. The General Electric Company has never observed any particular secrecy in regard to printed drawings, tracings and blue prints, and it is not known that any other electrical construction company in the United States holds such matter as sacred. Through changes of employés, many of whom, in the electrical business especially, are greedy collectors of blue prints and electrical data, it is easily seen that no company can successfully keep its ordinary technical matter out of the hands of competitors.

It is also not an uncommon practice for a purchaser to turn over to a successful competitor the plans he had procured from rivals; they are no longer of use to him, but may place much valuable information at the service of the recipient. In this manner, no doubt, considerable matter is accumulated, but the official interviewed stated he had abundant reason for believing that the Westinghouse Company had much more matter of the General Electric Company than the latter had of them, and that the object of attack was partly to influence the price of stock, and by implication to assert superior engineering ability.

The Proposed New Units.

BY J. R. ROSEBRUGH.

With few exceptions the units proposed by the committee of the American Institute of Electrical Engineers seem natural and useful. The weber and the gauss, although 100,000,000 C. G. S. lines seems rather high for practical purposes, are yet so admirably related to the volt that they may with great advantage be added to the units already in use. But when we consider the value proposed for the gilbert as a unit of magnetomotive force, namely, $\frac{1}{4\pi}$ ampère turn, the case is altogether different, a departure from the simple numerical relation of the preceding units being introduced by the presence of the factor 4π. However admirable this quantity may be in its own way, it is not welcome in a system of units. It has been said that it is impossible to get rid of it altogether; and although this is true, it is possible to put it in a less offensive position than the present, as I will attempt to show. It is customary to obtain a "line integral of magnetic force" by supposing a unit pole to pass around the magnetic circuit, the value of the integral being the work done on this pole. Now, the unit pole is an imaginary entity consisting of 4π symmetrically radiating lines, and the problem really consists in finding the work done in the intersection of these 4π lines by the conductors, which is of course just 4π times as great as that done by the conductors on one C. G. S. line. In fact we may use the work done on the intersection of any definite quantity of magnetic flux by the conductors as a measure of the magnetomotive force of those conductors.

Now, in questions of this kind it is always usual to select the unit quantity, or mass, on which to suppose the operation performed; as, for instance, work done per gram against gravitation gives us gravitation potential; work done per unit quantity of electricity gives electrostatic potential; thus we have in each case two factors for a quantity of energy—one the potential factor, the other the mass factor.

Thus in the case under consideration the magnetomotive force is the potential factor, and magnetic flux the mass factor. Now, surely if the weber be adopted as the unit of magnetic flux, it must be inconsistent to use any other quantity than the weber as the mass factor in the relation:

Unit M. M. F. $\times$ unit magnetic flux = unit energy.

Taking practical instead of absolute units, and substituting the value of the unit of magnetic flux recommended by the committee, we have:

$$\text{Unit M. M. F.} \times 1 \text{ weber} = 1 \text{ joule},$$

or,

$$\text{Unit M. M. F.} = \frac{1 \text{ joule}}{1 \text{ weber}} = \frac{1 \text{ watt-second}}{1 \text{ weber}} = \frac{1 \text{ volt-second} \times 1 \text{ ampere}}{1 \text{ weber}} = \frac{1 \text{ weber} \times \text{ampère}}{1 \text{ weber}} = 1 \text{ ampère}.$$

(remembering that the weber is a volt-second, or that the volt is one weber per second).

We may tabulate the work equivalent of several linkages of electric and magnetic circuits as follows, noting that 1 ampère = $\frac{1}{10}$ absolute unit, and that 1 joule = 10,000,000 ergs:

$$1 \text{ unit current} \times 1 \text{ unit pole} = 4\pi \text{ ergs},$$
$$1 \text{ ampère} \times 100{,}000{,}000 \text{ poles} = 4\pi \text{ joules}.$$

From these we get

(a) $\frac{1}{4\pi}$ unit current $\times$ 1 unit pole = 1 erg.

(b) $\frac{1}{4\pi}$ ampère $\times$ 100,000,000 poles = 1 joule.

It is apparently from (b) that the idea of using $\frac{1}{4\pi}$ ampère as practical unit has arisen; it will be noticed that in this relation (b) 100,000,000 unit magnetic poles is virtually recognized as a unit of magnetic flux, and therefore as a rival of the weber, its value being 4π webers. We may then write

$$\frac{1}{4\pi} \text{ ampère} \times 4\pi \text{ webers} = 1 \text{ joule},$$

and therefore (c) 1 ampère $\times$ 1 weber = 1 joule, as is well known. Surely no one would be enthusiast enough to require us to preserve two 4π's in a relation of this kind when they extend so evident an invitation to cancel them. Can there be any doubt, then, on comparing the exceedingly natural relation (c) with that which precedes it, that the latter identifies the natural unit of M. M. F. with the ampère (turn)?

If the ampère were adopted as the unit of M. M. F., we should then have this symmetrical arrangement

$$\left.\begin{array}{l}\text{Unit E. M. F.} = \text{volt} = \text{joule per coulomb} \\ \text{Unit M. M. F.} = \text{ampère} = \text{joule per weber}\end{array}\right\}$$

The peculiar conjugate relation between quantities of electric and magnetic flux may be exhibited as follows: Let dQ = quantity of electric flow *around*, and dN the quantity of magnetic flux *into*, a magnetic circuit in the time dt. Then the work done, dW, is expressed as follows:

$$dW = \frac{dQ\ dN}{dt} = \frac{dN}{dt}.\quad dQ = \text{volt-coulombs},$$

or

$$\frac{dQ\ dN}{dt} = \frac{dQ}{dt}.\quad dN = \text{ampère-webers},$$

the second factor being a mass factor, and the first a potential factor, in each case.

The value of H being found from that of the M. M. F. simply by dividing by a length, its value will be affected by any change in the value of the M. M. F., or

$$H \propto \text{M. M. F.}$$

So that instead of $\frac{1}{4\pi}\int H\ dB$ and $\frac{1}{4\pi}\int B\ dH$ as values of hysteresis for a cycle, we should obtain simply $\int B\ dH$ and $\int H\ dB$. This is certainly an improvement, and an indication, as it seems to me, that we are on the right track

In the determination of the units coulomb, volt and ohm for the electric circuit, the unit of current being first fixed, and therefore the coulomb also, that of E. M. F. was next deduced so as, in combination with the already determined unit of quantity, to give the joule or unit of energy, a unit common to all branches of dynamics, the unit of resistance being left to take whatever value became necessary.

So also, it appears reasonable to suppose, should we in determining units for the magnetic circuit, by analogy, having first fixed the unit of magnetic quantity, the weber, proceed by the energy relation to fix the unit of the M. M. F. as a joule per weber or ampère (turn), leaving the reluctance to take whatever value becomes necessary. In the case of the electric circuit the course pursued has led, as is well known, to a value of the ohm which stands in no simple relation to the resistance of unit volume of any known substance. Why, then, should anything different be demanded for the magnetic circuit? It is true that the adoption of the joule per weber or ampère (turn) as practical unit of M. M. F. would condition 4π times the reluctance of unit volume of air as unit reluctance, but in this respect this unit is at least no worse than the ohm. Nor does it appear that any disadvantage or inconvenience is likely to arise from the fact that the permeability would, on the joule per weber or ampère (turn) basis, be 4π times as great as on that proposed by the committee, for in any case a table of values of permeability would be necessary for magnetic substances, and for air and non-magnetic materials 4π instead of 1. Now, since in magnetic circuits the air gap reluctance, if it occur, is only one of a number of terms to be summed, it is of little importance if another factor than unity be used in this one, and of none whatever if, as is customary in English speaking countries, measurements are made in inches, and therefore require a reduction factor, which may easily be made to include the 4π. For these reasons, then, I believe that the advantage lies with the joule per weber or ampère turn as unit of magnetomotive force.

School of Practical Science, Toronto, Can.

Non-Synchronous Alternating Current Motors.

BY DR. BEHN-ESCHENBURG.

In almost all electrotechnical journals there have lately appeared articles on non-synchronous alternating current motors, which to one who has opportunity of making systematic investigations with such motors appear to be inaccurate in essential points and to misstate the fundamental principles of the motor. Following Elihu Thomson, we shall call an alternating current motor, whose performance depends upon the effect of "inducing" currents on induced currents, an induction motor. Accordingly, as the inducing currents used in the whole system of the exciting windings of the motor have the same phase, or may be separated into more phases, the induction motor may be designated as a single or a polyphase motor. The general principle of the induction motor was, as far as I know, first patented by Elihu Thomson; it is as universal as the inductive effect of alternating currents, and can therefore not characterize only one special efficient motor. The first induction motors were single-phase motors; the invention of polyphase motors then soon forced the single-phase motor so completely in the background that until very recently nothing has been known of a single-phase motor which has shown itself to be commercially efficient. Tesla's methods of the year 1889, to put the single-phase motor in operation by periodical transformation of the single-phase motor into a two-phase motor of the Ferraris type, had so little success that they seem to have been altogether abandoned by the inventor.

In the summer of 1892 I observed in the laboratory of the Maschinenfabrik Oerlikon, that a two-phase motor, constructed according to Ferraris' arrangement, which had been started from a state of rest, with its full load, and run to approximately synchronous motion, retained its power when the circuit of one phase was interrupted, or when the circuits of the two phases, by regulating their resistances, were made the same, or when the circuits were placed in series with each other; that is, when the currents were made to have the same phase. By this method of manipulation the energy consumed by the motor was reduced to less than one-half of its former value. Seeing this, the problem of the single-phase motor appeared to me to be solved, and I succeeded without making any further changes, by simply switching over, to transform every type of three-phase motor of the Maschinenfabrik Oerlikon into single-phase motors of a power equal to that for which they had been intended as three-phase motors. When all the windings of the three phases of the three-phase motor were connected in series for the single-phase motor, then, for the same power, the single-phase current had three times the voltage as one phase of the three-phase current for which the motor was built. Starting at full load succeeded with most of these motors, without further difficulty, by simply converting the single-phase motors (i. e. the original two-phase motors) into two-phase motors while starting, and until they had reached approximately synchronous motion. Ferraris' arrangement was chosen for this purpose, the two parts of the inductive windings being constructed with a different number of turns of self-induction, and different ohmic resistances. By means of a long series of experiments on the same model I then endeavored to discover the principal differences in the operation of a one, two, or three phase motor. The results are, in part, embodied in different patent applications of the Maschinenfabrik Oerlikon; they showed for the single-phase motor, and for the starting torque of the polyphase motor very decided radical limitations for the old Thomson and Tesla construction of induction motors. These new points of view explained at the same time why motors constructed according to the old principles never came into the market. Furthermore, even the latest announcements on this subject by Mr. Brown and others were shown to be erroneous in many essential respects, and to be insufficient to characterize a rational motor, aside from the inaccuracies relative to the priority of the method. The claims of Messrs. Leblanc and Hutin to the invention of a single-phase motor, which they thought they described in La Lumiere Electrique, 1890, vol. 40, 41, are surprising. We find there a theory and a description of the two-phase motor, the conclusions from which are directly against the advantages of the single-phase motor, as Mr. Brown has also stated. While it is an excellent method to start the single-phase motor of full load by transforming it into a two-phase motor by means of a simple switching over, Leblanc gives as the result of his investigations that his two-phase motor can not start on a load unless the circuits for the induced currents be provided with regulating resistances or condensers. While, furthermore, the practical running of the single-phase motor alone shows that, once in motion, it should have a perfectly homogeneous inducing system of windings, Mr. Leblanc utters the prophecy of the unsurpassability of his two-phase motor. I shall return to that later. Moreover, an answer from the original patentees of induction motors, Thomson and Tesla, may be expected; the description of the performance of an efficient motor, constructed according to their patents, need not, however, be expected. The principle, however, that by means of the electromagnetic effect between an inducing and an induced current the conductors of the one system may be put into some motion or rotation is, as is well known, as old as the discovery of the general effect of induction; the great Faraday himself had experimented with interest with such rotating apparatus, and described it minutely; as long as it is a question of the priority of the principle no technical man will doubt Faraday's priority. That the alternating current motors of the Maschinenfabrik Oerlikon are, however, the first, and, until now, perhaps, the only efficient single-phase motors constructed on rational principles, and used successfully in practical work, can probably not be disputed by any one by proof to the contrary.

I will now show what are the new fundamental principles of these motors, and what important points have been disregarded by the different writers and constructors. The points to be considered are the method of operation of the single-phase motor, so long as it maintains a certain speed of rotation, and the means of putting in into motion; of the latter, the first method to be discussed will be the temporary transformation of the single-phase motor into a polyphase motor; the second, its change into a series motor, and, finally, two arrangements invented by myself, directly arising from the nature of the single-phase motor; the one consisting in an arbitrary rotation of the exciting system by means of a commutator; the other consisting in cutting in and out at will suitable induced turns by means of brushes and collector rings.

In order that, from the very beginning, I may confine myself in this explanation to precise expressions, I shall first give that equation which characterizes the single and the polyphase motor, in its ideal form. The single-phase motor consists essentially of a single system of inducing windings arranged in series, the beginning and end of which are connected with the two terminals of an alternating current dynamo or transformer. The magnetic lines of force induced by the current cut the secondary windings,* which are so arranged that a number of short circuited coils are distributed at equal angular distances on the ring of the rotating armature. The polyphase motor consists of a number of systems of inductive windings, the number depending on the number of phases, the alternating current in each system having the same frequency, but having a different phase from the current in the other winding; the secondary should consist of at least an equal number of short-circuited coils, as the exciting winding has different phases. The windings of the secondary currents are distributed in like manner as those of the single-phase motor.

We will assume a two-pole motor and designate the resistance of the inducing coils by R, the coefficient of self-induction by L, and the same quantities of the secondary circuit by r and l; the coefficient of mutual induction between an inducing system of phase K, with a secondary circuit whose index is h, by M_{kh}; the current and difference of potential of the inducing coil K by i_k and E_k; the current of the secondary h by j_h. For simplicity we shall assume that the electromotive force is a simple sine function of the time, that the coefficients L and l are the same for every position of the motor, and that the different sections of the inducing coils, as also the sections of the secondary coils, affect each other in such a way that they do not change the form of the equations, which is true in the cases considered. Their effect consists, in fact, in increasing the coefficient of self-induction.

The single-phase motor, as well as the polyphase motor, therefore, in any position, is perfectly analogous to the ordinary alternating current transformer, and we may therefore say that one of the first conditions in the construction of a good motor is that in every position it should be the best possible transformer. It is readily seen that a certain stress should be laid on the point that the motor in every position should be equally effective, for if there are positions in which the motor is less effective than in others, then these positions for the rotating motor mean phases of smaller burning moments, and when the motor is at rest these act like a brake.

The equations for the single or polyphase motor are analogous to the equations of a transformer; using the symbols given above we have in general:

$$i_k R + \frac{di_k}{dt} L + \frac{d}{dt} \Sigma^h M_{kh} j_h = E_k \qquad (1)$$

$$j_h r + \frac{dj_h}{dt} l + \frac{d}{dt} \Sigma^k M_{hk} i_k = 0. \qquad (2)$$

For the single-phase motor k is always the same, therefore, $\Sigma M_{hk} i_k$ becomes equal to $M_h i$; the construction seeks to obtain the relation that M_h can be expressed by $M_h = M \cos v_h$; v_h being the angle of rotation that the circuit takes in the position considered. In the polyphase motor we seek, on the other hand, to produce a most nearly homogeneous, rotating magnetic field by making M_{kh} independent of the angle of rotation; in other words make it constant; that is, the variation of the magnetic field is produced, not by the variation of the angle of the induced current surfaces with respect to the inducing lines of force of a definite phase, but by rotating the direction of the resultant induced lines with the phase of the inducing system. In the single-phase motor the inducing lines of force have always one or the opposite direction with varying number and intensity; in the polyphase motor the direction of the lines of force rotates; the number of the lines should always be the same. The single and polyphase motor can only then reach their highest efficiency when the induced system consists of more than one independent circuit; in both is then formed, in the inductor system, a so-called rotating field. It is these fundamental properties which, in the articles published heretofore, have been disregarded; without the consideration and knowledge of which, however, the construction of an efficient induction motor becomes merely a matter of chance. If the exciting system of the polyphase motor and the inductor system of the polyphase and single-phase motor is divided into so many independent phase sections regularly distributed upon the exciting circle or inductor circumference that, instead of a simple summation of the single sections, the effect can be integrated according to the angle of rotation, then the equation reads:

For the polyphase motor:

$$i_v R + \frac{di_v}{dt} L + \frac{d}{dt}\int M j_v \, dv = E_v; \qquad (3)$$

$$j_v r + \frac{dj_v}{dt} l + \frac{d}{dt}\int M i_v \, dv = 0. \qquad (4)$$

For the single-phase motor:

$$i R + \frac{di}{dt} L + \frac{d}{dt}\int M \cos v \, j_v \, dv = E; \qquad (5)$$

$$j_v r + \frac{dj_v}{dt} l + \frac{d}{dt} (i M \cos v) = 0. \qquad (6)$$

If the inductor rotates with angular velocity $2 \pi n_1$ and we reckon time from $t = 0$, then, in the polyphase motor, in time t, that phase of the exciting system becomes maximum in its effect in a certain section of the inductor, which lags by the angle $2 \pi n_1 t$ behind the phase which at the instant $t = 0$ was in maximum position of power; and conversely, that inductor section comes in the instant t into its maximum effect with respect to a certain exciting phase which is ahead by the angle $2 \pi n_1 t$ of that section, which section in the beginning was in the position of the same effect. The maximum effect, according to this method of expression, becomes coincident with the distribution of the maximum intensity of the current in the separate phases or sections in the given period of time.

We therefore assume that

$$E_o = E \sin (2 \pi n_1 t + v),$$

and make, by way of trial,

$$i_o = T \sin (2 \pi n_1 t + v - \alpha).$$

The equation (4) then reads:

$$j_v r + \frac{d\, j_v}{dt} l + \frac{d}{dt} M T \sin [2 \pi (n - n_1) t + v - \alpha] = 0.$$

Hence it follows:

$$j_v = \frac{M T 2 \pi (n - n_1)}{\sqrt{r^2 + [2 \pi (n - n_1) l]^2}} \sin [2 \pi (n - n_1) t + v - \alpha - \beta]$$

$$\tan \beta = \frac{r}{2 \pi (n - n_1) l}. \qquad (7)$$

If I represents the amplitude of j_v, we have the analogy

$$i_v R + \frac{d\, i_v}{dt} L + \frac{d}{dt} M I \sin [2 \pi (n - n_1) t + 2 \pi n_1 t + v - \alpha - \beta] = E_v.$$

If we substitute the abbrevation $r^2 + [2 \pi (n - n_1) l]^2 = \rho^2$, and if for the simplification of the formula we assume that the dissipation of the magnetic lines of force in the motor is small and the self-induction of the inducing system very large compared with the resistance, then it follows approximately

$$T^2 = \frac{E^2 \rho^2}{(2 \pi n L r)^2 \left[\frac{1 + 4 \pi^2 (n - n_1)^2 (L l - M^2)^2}{L^2 r^2} - \frac{R^2 \rho^2}{(2 \pi n L r)^2} \right]}. \qquad (8)$$

If the leakage is altogether negligible, then, as is well known, $L l = M^2$.

In synchronous motion of the polyphase motor when we must place $n_1 = n$, then $\rho^2 = r^2$, the induced current strength $I = 0$, and for the current for no load of the inducing system we obtain

$$I_o = \frac{E}{2 \pi n L}; \quad \tan \alpha = \frac{2 \pi n L}{r}. \qquad (9)$$

The current required to run the motor without load, therefore, agrees with that which enters the inducing system when the circuits of the induced system, therefore the secondary windings of the motor transformer, are open. The work on no load in the polyphase motor is therefore entirely analogous to the so-called work of magnetization in an ordinary transformer. Various measurements made on three-phase motors give results in agreement with the theoretical conclusions; the consumption of the motor on no load in current and watts was found to be nearly equal to the consumption on open induced system; as when, for example, the inductor windings were left off altogether. It follows, therefore, that the polyphase motor in its useful work can equal the performance of the alternating current transformer, and that the calculation and construction of both is to be carried out upon the same basis. In fact, a useful power of 90 per cent. made by brake determinations has been obtained from a 15-h. p. rotating current motor of the Maschinenfabrik, Oerlikon.

(To be continued.)

* Owing to the want of a well understood word for the windings in which currents are induced by the currents in the inducing windings, the translator will use the term "secondary" for the former (that is for the windings on what usually forms the rotating part armature) and "primary" or "inducing" for the latter usually the fixed windings).

LEARLY will the electrical fountains, which we take as our text this week, be the most brilliantly spectacular of this most brilliant electrical display the world has ever seen. As far back as our issue of Jan. 21, we gave to our readers a most highly illustrated description of the plans as then developed, and much of the descriptive matter and practically all of the cuts then presented might be used at this time with as strict accord with propriety as then. Our first description was of the results, as it was hoped at the time they might be. To-day we give them as they are and the means by which they have been obtained. In our earlier effort we were by the nature of the case confined to more general statements, but how far they were correct will be strikingly illustrated by the present detailed description of the actual state of affairs. The original plans—that is, working drawings, have undergone some minor changes as will be seen by a comparison of this with a description of the fountains that recently appeared in the pages of a contemporary which boasts that its drawings are copies of the original plans. As might be surmised, we have gone to the works themselves—that is, the fountains, and we believe that our statements here made will be found the only reliable ones thus far published on this most interesting subject.

Near the eastern end of the Palace of Mechanic Arts is situated the electrical generating plant which supplies the current for the electrical illumination of the fountains This consists of four 175-kilowatt 140-volt bipolar Edison generators, arranged in a line on a transverse aisle. These present a striking appearance from their color. The fields are wound on the outside with white cord, the pole pieces and bases are painted white, as are also the ends of the field yokes, while the switchboards on the front of the yokes are of white marble, as are also the rear faces of the yokes. In fact, nothing but the brass and the black switch handles have any color but white, and the contrasts with the surroundings are agreeable and striking. The switchboard for the control of the circuits is not yet erected, but will stand on the main aisle and will also be of white marble. It will be 21 feet long and 7 feet high, with polished brass and copper trimmings. The commutators are 14 inches long, 12 inches in diameter and are composed of 41 segments. The shafts are 5 inches in diameter and are driven by pulleys 44 inches in diameter and 21 inches face.

THE WHEAT SHEAF.

These four generators are coupled up two and two for the three-wire system, and each pair is belted direct to the flywheels of separate engines.

In addition to supplying current to the fountains these generators will do other duty when required, chief of which will be the charging of the storage batteries used on the electric launches described in our issue of April 29.

As stated, these machines are driven by two engines—the one nearest the main aisle being a Ball 600-h. p. cross compound, with cylinders of 20 inches and 38 inches and 18 inches stroke, and running at 224 revolutions. This has already been described in our issue of April 29 as probably the largest high-speed engine in the country. In keeping with the color of the dynamos, the ironwork is enameled white. The two flywheels are each 7 feet in diameter, with 22 inches face. The engine runs condensing, using a Worthington condenser, located directly to the south. The other engine, to the west, is a simple Armington & Sims high-pressure engine, with 21-inch cylinder and 18-inch stroke. Its rated capacity is 400 h. p. at 225 revolutions. It also has two flywheels 7 feet in diameter and 24 inches face. The belts used on both engines are furnished by the Chas. A. Schieren Company.

ELECTRICITY BUILDING AND ELECTRICAL FOUNTAINS.—LOOKING SOUTH.

THE WORTHINGTON PUMPS.

In a separate building directly east of the boiler annex to the Palace of Mechanic Arts is the pumping station for the Fair grounds. This is the display of the Worthington Pump Company, and the four pumps they have there erected are intended to represent the four main types which that firm is putting on the market. To the mechanical and civil engineer this display has an intrinsic merit of its own. To us it is of especial interest on account of the part which it plays in the electric fountains, which form the subject of this article.

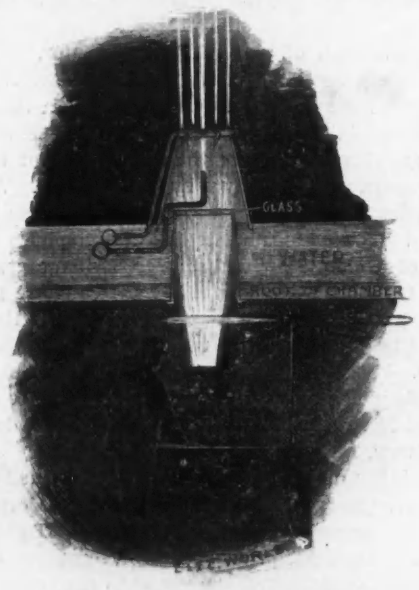
While all of the pumps work in the same large primary main, and any of them may be employed for each of the various duties to which they may be called, the large vertical engine, illustrated herewith, is the one specially assigned to the two electric fountains, and the McMonnies fountain between them. This has an extreme height of 51 feet and a daily pumping capacity of 15 million gallons, and is what is termed a vertical compound low duty pumping engine. In this there are two cylinders, the high-pressure steam cylinder being 30 inches in diameter, and the low-pressure 60 inches. The plunger is 32 inches, and is "outside packed." It makes 52 strokes per minute of 5 feet in length, and operates under 125 pounds of steam pressure. The water from this, as in the other pumps, is under 100 pounds pressure, and the safety valves, of which there are 10, located in the basement, are set to move at 101 pounds. The low-pressure steam cylinder is connected with an independent Worthington condenser, also located in the basement.

Just west of this is located the Worthington high-duty compound pumping engine, which is more especially assigned to fire service, but, as before stated, also connected to the great 48-inch main, from which branch the McMonnies and electric fountain supplies. In case of fire, however, the connections with the fountains would be cut off and the water carried in another direction through a 36-inch main. In this engine there are two high-pressure steam cylinders of 25 inches diameter, and two low-pressure cylinders of 50 inches diameter. These are arranged tandem, and operate two plungers, each 27 inches in diameter and 38 inches stroke. The special features of this engine are the accumulator attachment and compensating cylinders, for the purpose of storing up the energy during the first half of the stroke, and giving it out during the last half. These devices permit the cutting off of steam at 1-3 stroke. In the case of breakage of one of the mains no injury could result to the engine, for, since the steam is cut off automatically, it would stop on its centre. The capacity of this engine is 12½ million gallons.

In the northeast corner of the pump house is the double expansion three cylinder engine. In this there are two 15-inch high-pressure cylinders, both exhausting into a single intermediate cylinder of 33 inches, and this into the low-pressure cylinder, which is 57½ inches in diameter. This engine is single-acting and 38-inch stroke, and its capacity is 7½ million gallons. The low-pressure cylinder is connected with a Worthington independent condenser.

The fourth pump is not yet erected, but will be placed on foundations already completed in the northwest corner of the building. The dimensions will be as follows: High-pressure cylinder, 9½ inches; intermediate cylinder, 15 inches, low-pressure cylinder, 25 inches; plunger, 11 inches, and length of stroke, 48 inches. This will be what is termed a high-speed pumping engine, and its capacity 5 million gallons.

The water for these pumps comes direct from a large well beneath the floor, into which it is conducted by

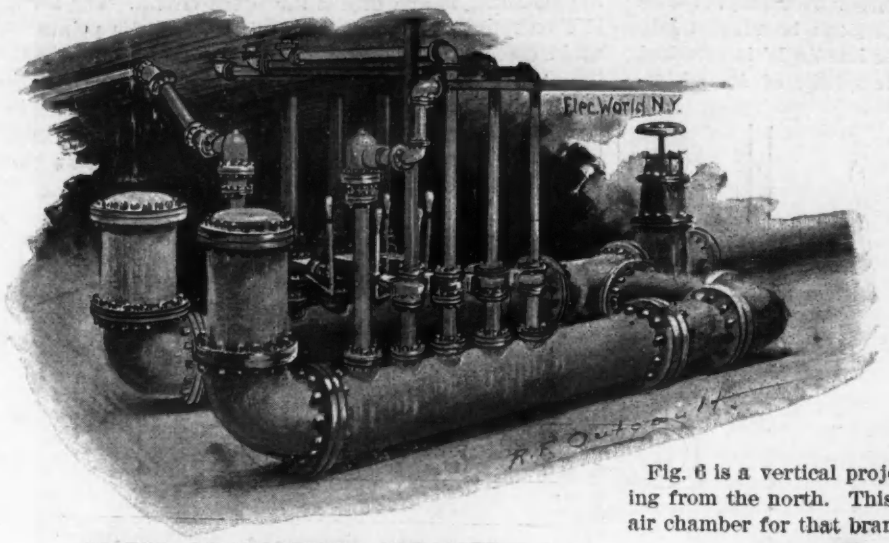


A DETAIL OF JET ILLUMINATION.

gravity through large mains from the south basin to the east. Into this well also flows the waste water from the

safety valves when the pumps are working beyond the consumption.

The pressure at which the water is supplied to the mains (100 pounds) would give a theoretical head of about 230 feet. To this must be added the additional head due to fall between the pumping station and the fountain jets, and there must be subtracted the loss of head due to friction of all kinds, and, in the case of the vertical jets, that due to the resistance of the descending column of the jet. None of these data are at hand, but it is confidently believed that a height of from 150 to 175 feet may be attained when desired.



WATER CONNECTIONS FOR JETS.

The dimensions of the steam pipes in this plant are as follows: Main steam line, 12 inches; that feeding the vertical engine, 6 inches; that feeding the horizontal engine, 5 inches, and the connection with the triple engine, 4 inches. The fourth engine will receive steam through a 4-inch pipe. All of these are covered with asbestos insulation by the H. W. Johns Company, who have made an exceedingly neat and attractive job, as the covering is bound on by polished brass hoops, which show in beautiful contrast to the white of the covering.

ENGINE SIGNALS.

Means of communication between the engines and fountains was, of course, necessary, and has been supplied by an electric bell with the following code of signals:

One short ring	Open up partly.
Two short rings	Open up more.
Three short rings	Open up still more.
Four short rings	Close partly.
Five short rings	Close more.
One long ring after either three, four or five short rings	Stand by to close down.
Three short rings repeated	Close partly.
Three short rings followed by two short ones	Close down.

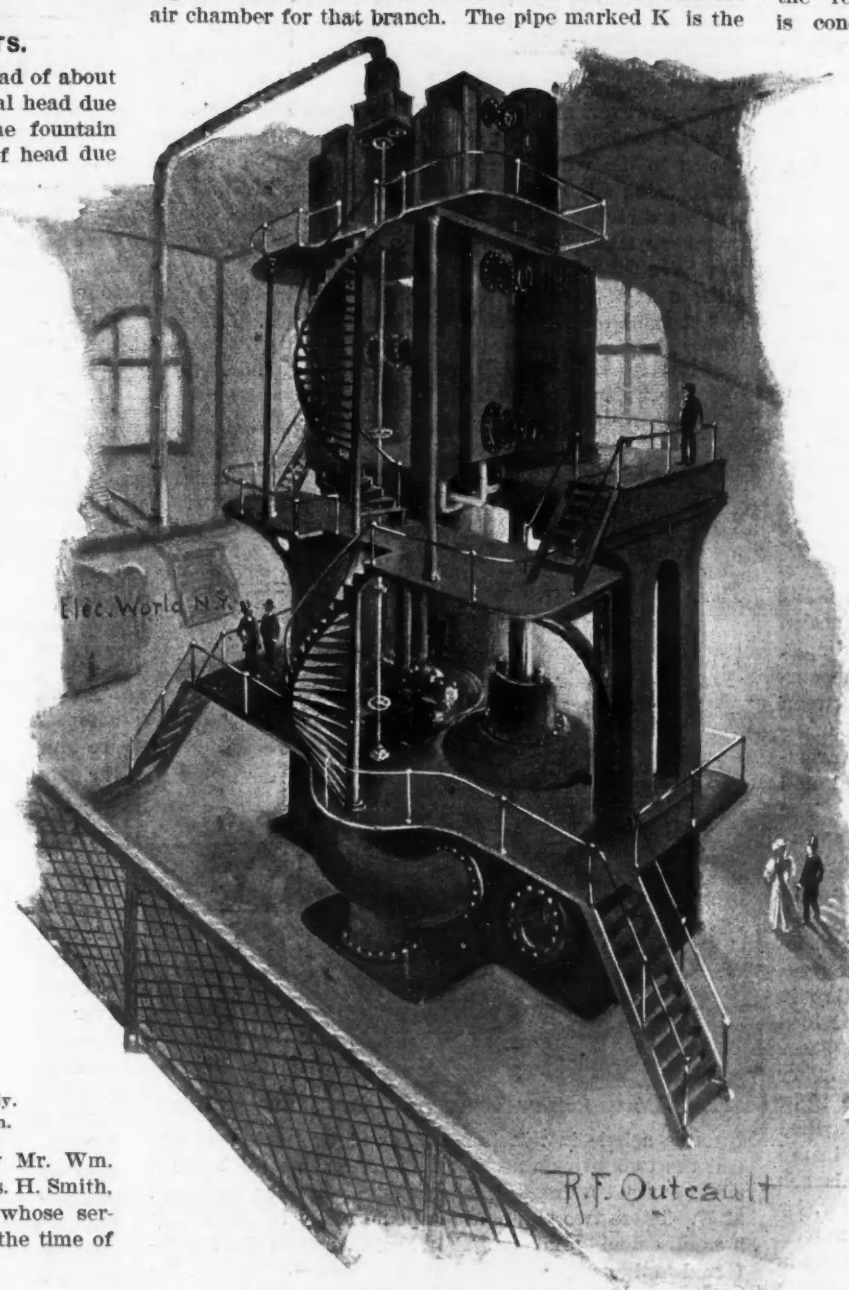
These engines and pumps were erected by Mr. Wm. Kirkbridge, and are being operated by Mr. Chas. H. Smith, of the Memphis Artesian Water Company, whose services have been lent by that company during the time of the Exposition.

THE PIPE CONNECTIONS.

All of the water pumped at the pumping station for the fountains, leaves the building through a 48-inch main, which branches into a 36-inch main for the McMonnies or Central fountain, and into a 24-inch main for the two electric fountains. This latter main again branches into two 16-inch mains, one of which leads to the operating chambers under each of the electric fountains. Here they divide again, as shown in plan in Fig. 5, and from each of these two arms, which terminate in vertical air chambers, shown in plan in Fig. 5, and in elevation in Figs. 6 and 7, rise the supply pipes for the various jets and the two blow-off valves. These are also shown in plan in Fig. 5 together with the gate valve M, by which the total water supply to each fountain is controlled.

The water pipes enter the chamber from the west side, and the two branches run parallel in an easterly and westerly direction, both branches being of the same size as the main from which they spring, viz., 16 inches in diameter.

Fig. 6 is a vertical projection of the south branch looking from the north. This shows on the extreme left the air chamber for that branch. The pipe marked K is the blow-off or safety valve and connections, which is so arranged as to blow off and relieve the pressure when by any chance it may rise to dangerous proportions. This pipe extends along the roof of the chamber to the south, where it empties into the waste weir.



THE BIG WORTHINGTON PUMP.

The pipes marked A, B and C are each six inches in diameter, and furnish supply as follows: B supplies the sprays or wheat sheaves which surround the outer circle of jets. This outer circle consists of twelve groups of two jets each. These rise from within the hood, the pairs being arranged radially and inclined inwardly at a small angle project, streams through nozzles 1½ inches in diameter. Pipe A supplies the water for the inner jets of these pairs, and pipe C for the outer ones. In all three of these pipes the controlling levers to the valves move in a vertical plane.

Turning around and facing to the north, we get the view presented in Fig. 8, which is a view of the pipes and valves in the north branch, looking from the south. To the extreme right is shown the air chamber in this branch, and next to it is the corresponding blow-off valve and escape pipe, which, after reaching the ceiling, runs directly west, as shown in Fig. 5, and empties into the waste weir.

Pipe D, which is but three inches in diameter, and the smallest of all the supply pipes, leads to the central nozzle of the fountain. It has no other duty, and is controlled independently of all the rest by its own valve, which, as shown, is controlled by a horizontally acting lever. Pipe E, 3½ inches in diameter, supplies the circle of small jets which encircles the central composite. In this circle there are 84 separate nozzles, each ⅜ inch in diameter.

The central composite, the central vent of which is supplied by pipe D, is surrounded at the top of the hood by a pipe from which spring seven jets also ⅝ inch in diameter. Surrounding this central composite are six other composites of similar pattern, each composed of a central vent, hidden beneath the hood and surrounded by a circle of seven ⅝-inch jets at the top of the hood. All of these "hood" jets, including those of the central composite, are supplied by the same pipe, viz., that marked H, which is 3½ inches in diameter, and the central jets of the six are supplied from pipe G. As will be seen from Fig. 8, pipes D and E, which supply the single central jet and the circle of 84 small jets respectively, are each controlled by horizontal levers. The other two on this side, G and H, which supply respectively the central jets of the six composites and all the hood jets, are controlled by vertical levers.

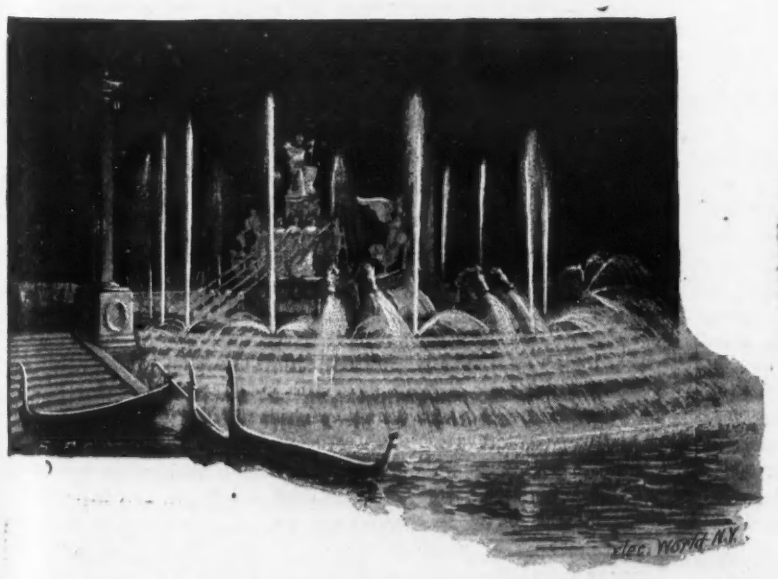
It may be mentioned here that the sprays which surround the hoods of the outer circle of 12 composites issue from small perforations in the pipe which surmounts the hood. These perforations are each ⅛ inch in diameter, and there are 116 of them to the wheat sheaf.

Summarizing, we find for the number of jets in each fountain, the following:

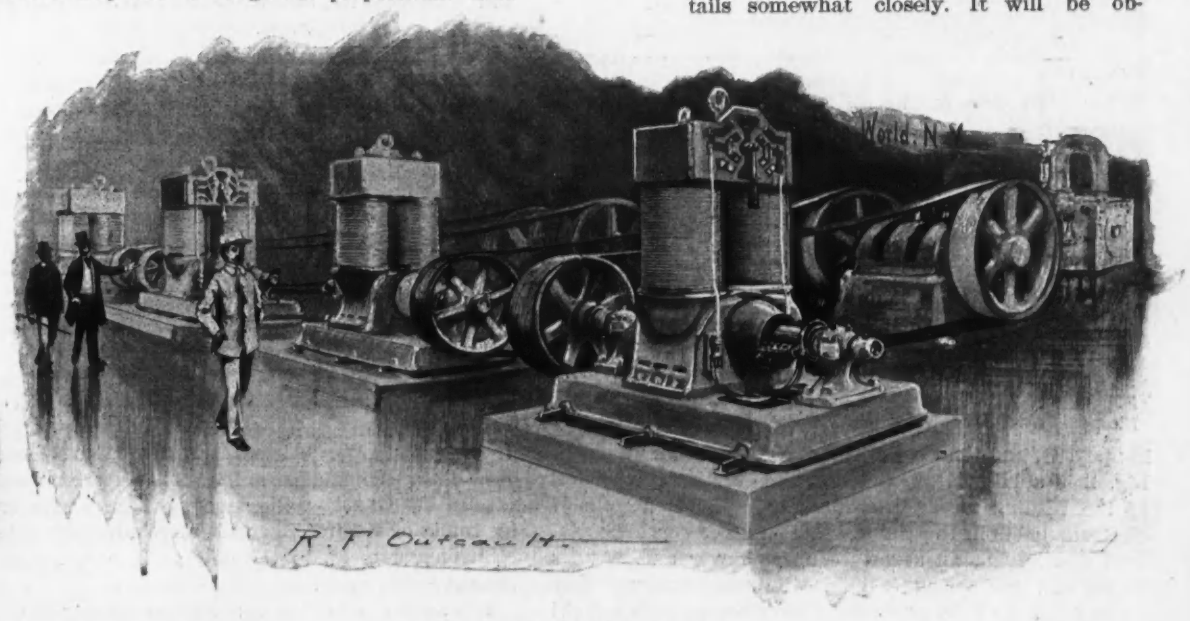
Central composite or central geyser	7
Central ring	84
Inner circle of composites 6 × 7	42
Central jets (2 each) of outer circle of composites (12)	24
Wheat sheaves (12, with 116 jets each)	1,392
Total	1,549
In the two fountains	3,098

THE LAMP.

The arc lamps for illuminating the jets are essentially what is known as the Standard T.-H. Marine search light, modified in certain particulars to adapt it to this special use. The fact that these are the first lamps made exactly according to this pattern renders it interesting to examine their details somewhat closely. It will be observed from Fig. 1 that the most radical change is that the carbons and major axis of the lamp are horizontal instead of nearly vertical, as in the usual search light.



THE McMONNIES FOUNTAIN.



THE GENERATING PLANT.

Referring to the figure, M is a guide rod upon which the two carriages carrying the carbon holders run, and S is the rod by which the feed is regulated. On this two screws are cut in opposite directions, the one to the left, which feeds the negative carbon, having but a single thread, and that to the right, which regulates the positive feed, having a double thread, so that a given angular movement feeds the latter twice as fast as the former. D and E are the clamps which usually hold the carbons. In these lamps, however, they do not clamp the carbons directly, but instead are each clamped to a brass tube, slotted and threaded at the end as shown, in which the

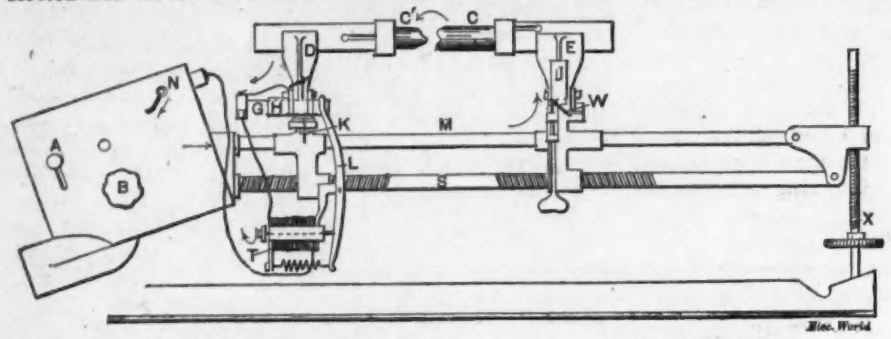


FIG. 1.—ARC LAMP FOR THE ELECTRIC FOUNTAINS.

carbons are inserted. A conically threaded cap is then screwed on, binding the tubes tightly to their carbons. This arrangement is an improvement in focusing lamps, permitting the carbons to be almost totally consumed before being replaced by others.

The hand screw K moves on a ratchet connected with H, which forms a telescopic joint with G, by which the distance between the two carbons can be roughly adjusted by hand. D, G and H, and, consequently, the negative side of the lamp, are perfectly insulated from the guide rod M, through which the positive current passes, by insulating discs of porcelain just above the hand screw K. T is a small electromagnet in the main circuit in series with the arc. The armature of this is connected by a rod central to the core to a long lever arm, pivoted centrally on the carriage and connected at the upper end with the telescopic joint above described. At its lower end it is pulled by a spring which tends to keep the armature away from the pole. This is the arc-striking device, and its action is exceedingly simple. The moment the current passes between the positive and negative carbons, the armature is attracted and the arc is struck. The balance of the spring against the magnet attraction also assists in maintaining a proper adjustment, which is supplemented by the feed mechanism in the shunt, to be described.

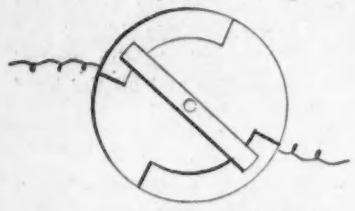


FIG. 4.—CUT OUT IN SHUNT.

The positive carriage has three hand adjustments, by which the carbon may be moved in three planes at right angles to each other. The screw Y gives a motion in the vertical plane passing through the guide M and feed bar S. The screw W gives motion in a horizontal plane, and another screw, not shown, imparts motion in another vertical plane at right angles to the first. At the right hand end of the diagram is an upright screw attached to the base of the lamp, taking into a female screw in the end plate, to which both the guide and feed rods are rigidly attached. To this is fastened a thumb-screw, by turning which the lamp as a whole may be moved through a small vertical angle. To the left of the cut is shown the box containing the feed mechanism, which is given below in detail in Figs. 2, 3 and 4.

The course of the current through the lamp may be traced by the arrows. It will be seen that it comes to the positive carbon through the guide rod M and returns to the circuit through the negative carbon C', clamp D, binding post G, and thence through the regulating magnet T. Fig. 2 is a horizontal, and Fig. 3 a vertical projection of the feeding mechanism. In Fig. 3, M is a pair of electromagnets in the shunt. K is a lever centrally pivoted and having an armature at its lower end. At its upper end the spring G holds the armature normally away from the pole, as shown. Attached to K is a pawl E, putting into a ratchet wheel D. On the same shaft with D is a small cogwheel C, meshing into the larger cogwheel A. Attached to the axle of A is a set of bevel gears to translate the motion 90 degrees, the second bevel gear giving rotary motion to the feed screw. The handle B is fixed to the axle of A, and constitutes a hand feed for the carbons, when such is desired. Normally, B does not clutch the axle or spindle, but can be thrown into clutch with it by pressure. The handle B' is attached to a sleeve fitting loosely over the spindle of A, and terminating in a beveled wheel also. This meshes into another on a shaft concentric with the feed screw S. Motion of B' does not give rotary motion to the feed screw, however, as does that of B, but sets in motion a rack and pinion gear (not shown) which gives longitudinal motion to the whole lamp. B' may therefore be called the focusing adjustment, for, by its use, the arc may be brought directly into the focus of the parabolic mirror whenever through irregular burning of the carbons it may have passed to one side or the other.

The next point of interest is shown in detail in Fig. 2. Attached to the lever K is an L shaped arm. Running

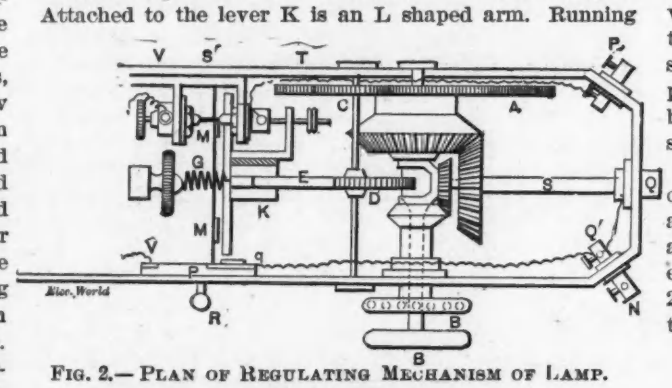


FIG. 2.—PLAN OF REGULATING MECHANISM OF LAMP.

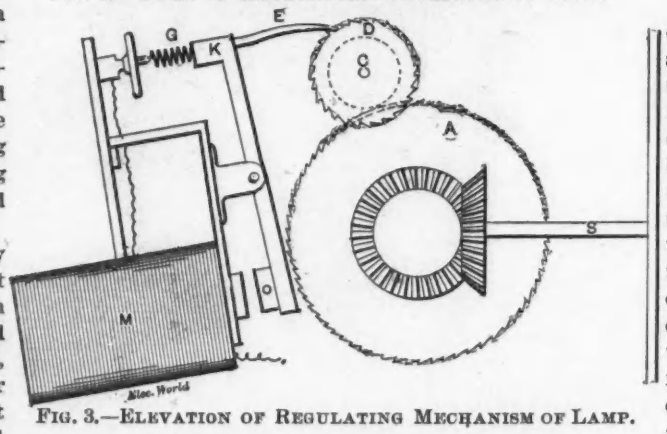


FIG. 3.—ELEVATION OF REGULATING MECHANISM OF LAMP.

through a hole in this is a brass rod containing at one end the two adjustable lock nuts T, and at the other a silver contact normally resting against another, as shown at S'. These two points are kept normally in contact by a small coiled spring (not shown) attached to the rod referred to, but which permits of their separation when the arm strikes the nuts T.

P is a cut-out shown in detail in Fig. 4, and P and N are the binding posts of the lamp.

The current enters the lamp at P, and is thence conducted to the guide rod by a connection not shown. Its course through the outside portion of the lamp has been traced back to Q. Thence it is carried to Q' and N and out. But the mechanism in this part of the lamp is wholly operated by the shunt, which starts from the inner end of P, through the contact points S', through the electromagnets M, to the cut-out P, and thence to the negative post at Q'.

The action is as follows: As the resistance of the arc increases the magnet M is energized sufficiently to overcome the spring G, and attracts its armature. The movement of the lever K to the right does two things. First, through the pawl E, it moves the ratchet wheel D, which through the train of gears turns the feed screw, thus feeding the carbons; and, second, it brings the arm against the lock nuts T, and breaks the shunt circuit. The lever K then returns to its normal position, and the points S' again come in contact, renewing the shunt circuit. If the feed has been sufficient, the armature will not be immediately attracted again, but if it has not been, the armature will again be attracted as soon as the circuit is closed, and this will be repeated until the feed is sufficient. In the Standard T.-H. search light, the positive carbon is 1¼ inches in diameter and the negative carbon one inch, and the spools are wound for 90 amperes. Our contemporaries, and, we believe, all other published accounts, have stated that the same figures hold with these lamps. Such is not the case, however. The lamps used in these fountains will use but 80 amperes, the positive carbon will be a cored carbon one inch in diameter, and the negative a solid carbon ¾ inch in diameter. As the standard search light is rated at something like 250,000 candle power (spherical measurement) these lights would give by the same process of reasoning about 8-9 as much, or something over 220,000 candles.

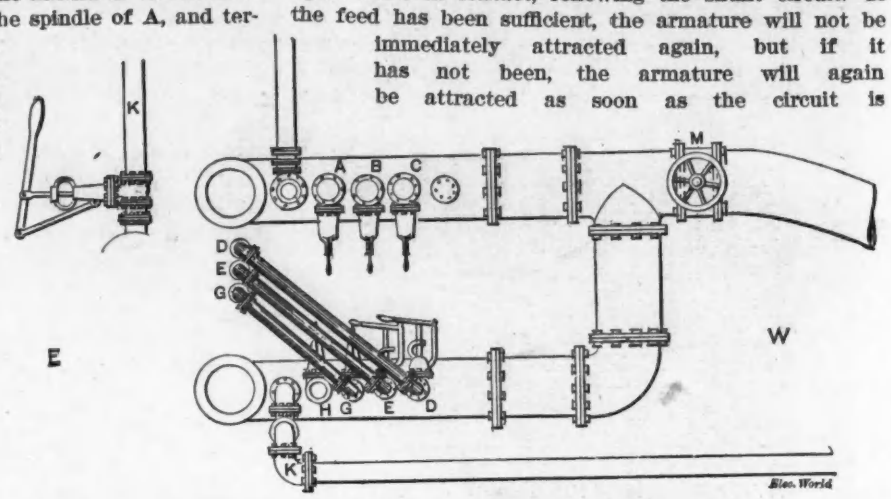


FIG. 5.—PLAN OF PIPES AND VALVES.

There are 19 groups of jets in each fountain, and each of these is illuminated by a separate arc lamp of the above description, whose total rays are reflected in parallel rays by silvered copper reflectors 22 inches in diameter and 12 inches deep. The focus in these reflectors is 2.04 inches from the apex of the paraboloid, and it is at this point that the arc will be maintained.

COLOR CONTROL.

As stated elsewhere, there are in each fountain 19 composites, and each of these is supplied with a separate arc lamp whose rays are projected upward axially with the jets. One of the drawings shows how the rays reach these jets from the chamber beneath the basin. For each composite there rises from the ceiling of the chamber to above the surface of the water a cast iron tube two feet in diameter, closed at the top by a plate of thick transparent glass. The pipe supplying water to the central jet, or the two pipes supplying water for the two central jets, as in the case of the outer circle of composites, are carried up the outside of these tubes and over the plate glass to its centre, where they are turned upward and terminated by the nozzle. Hiding all this from the view of the spectators is a hood of cast iron, considerably larger at the bottom, but contracting to about the same diameter at the top. This is open at both ends and at its lower end extends beneath the surface of the water. At the top it is surmounted by a circular pipe which is fed by a pipe of similar diameter led up on the outside of the hood, and in these circular pipes are inserted six 5/8-inch brass nozzles on all of the hoods except the twelve which form the outside circle of composites. In these latter, from which the sprays or wheat sheaves issue, the pipes themselves are perforated each by 114 1/8-inch holes from which the jets of water issue direct.

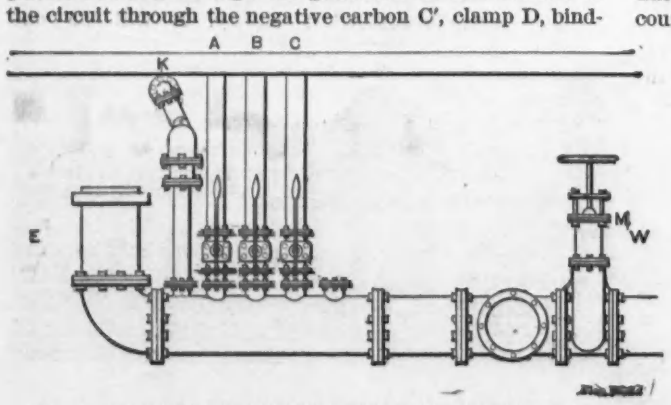


FIG. 6.—ELEVATION OF SOUTH MAIN, LOOKING SOUTH.

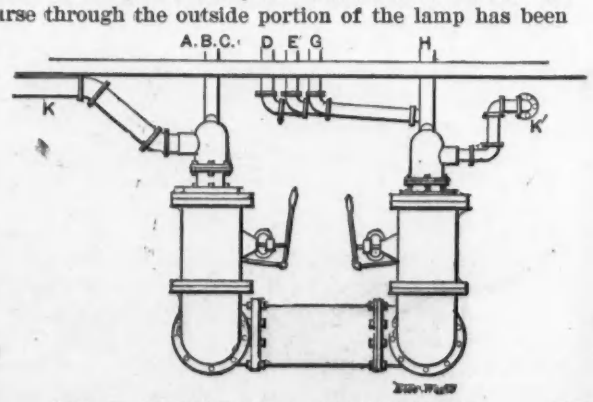


FIG. 7.—ELEVATION, LOOKING WEST.

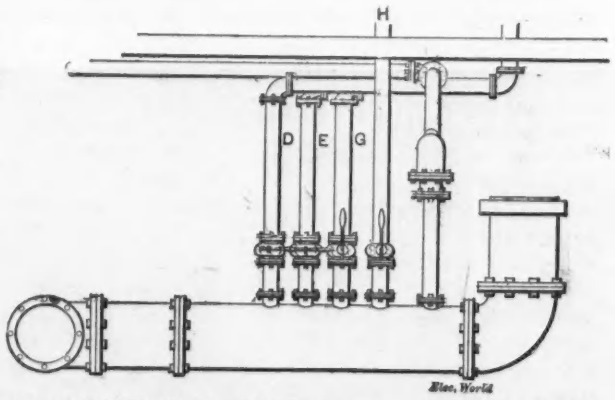


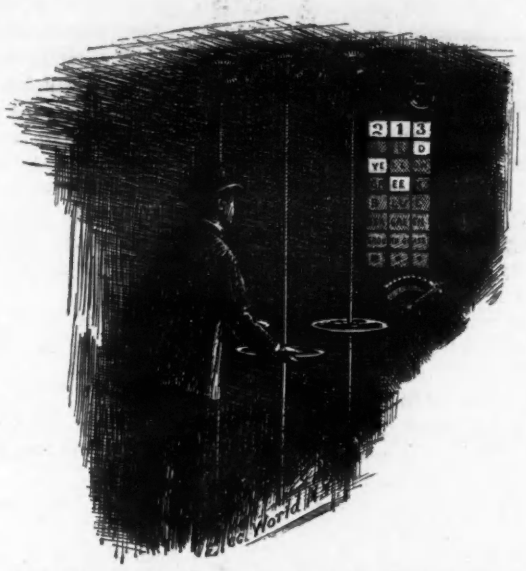
FIG. 8.—ELEVATION OF NORTH MAIN, LOOKING NORTH.

Blow-off Valve, Spray Valve, Jet Valve, Outer Circle and Main Controlling Valve.

For white light, the unobstructed rays from the arc lamps projected upward through the glass partition beneath the jets produce almost dazzling whiteness, but for colors, glass screens of the desired shades are interposed, and as these screens are red, blue or yellow or combinations of these colors, so do the water jets and sprays take on those shades in most brilliant hues. The screen itself consists of a six-leafed fan-shaped arrangement attached to an upright spindle, each leaf of which contains a different color. These are so situated

that by revolving them through a greater or less angled the broader portion of any of the leaves may be interposed in the path of the rays.

For purposes of convenience these screens are all controlled by three wheels arranged near the eastern edge of the chamber. These are numbered 1, 2 and 3; No. 1 being in the centre, with No. 2 on the left and No. 3 on the right of the operator as he faces west. As we have seen, the central water jet is under individual control. So is the color screen for the central composite, and this



THE COLOR CONTROL AND SIGNAL APPARATUS.

is controlled by the central wheel, or No. 1. The six composites surrounding the central one are similarly controlled by No. 2 and the twelve composites forming the outer circle are controlled in like manner by No. 3.

The method of imparting motion to all these fans is mechanically simple. The three wheels are attached to as many upright spindles extending from floor to ceiling. At the upper end of each the motion is imparted to horizontal shafting by bevel gear. In the case of No. 1 the central color screen is driven from this again by bevel gear. In the case of No. 2 the horizontal shaft imparts motion to three transverse shafts by means of worm gearing, and these in turn impart motion to the six color screens of that circle. No. 3 in like manner conveys motion to seven similar transverse shafts which connect with each of the outside circle of composites.

COLOR SIGNALS.

Directly in front of the color screen control apparatus and in view of the operator is the color signal box, which consists of an upright wooden box 2 feet 9 inches high by 1 foot wide. The face of this is divided into three vertical rows of windows, each row appropriate to one of the color screen controllers. Horizontally there are eight rows of three windows each. In the top row the panes are of ground glass and numbered as shown in the sketch—the number designating the color control apparatus to which that vertical row is to be the signal. The succeeding horizontal rows from the top to the bottom are filled with stained glass of the following colors—ruby, yellow, green, blue, sea-green; the seventh is filled with plain ground glass to give white and the eighth with ground glass with a central spot of black to indicate no change. Behind these windows are located 24 16-candle power, 120-volt lamps—one for each window. This signal box is operated from the northeast tower of Machinery Hall, where a similar signal box is situated, also a push button to give warning of a change of signals and a switchboard containing three vertical rows of single-throw switches and as many horizontal rows as in the signal box, each switch governing a lamp in the color signal box at the fountain. Each of these single throw switches is colored in accordance with the color which it controls in order to avoid as far as possible any confusion in operating.

1	2	3	4	7
PULSATE	5		6	PROJECT

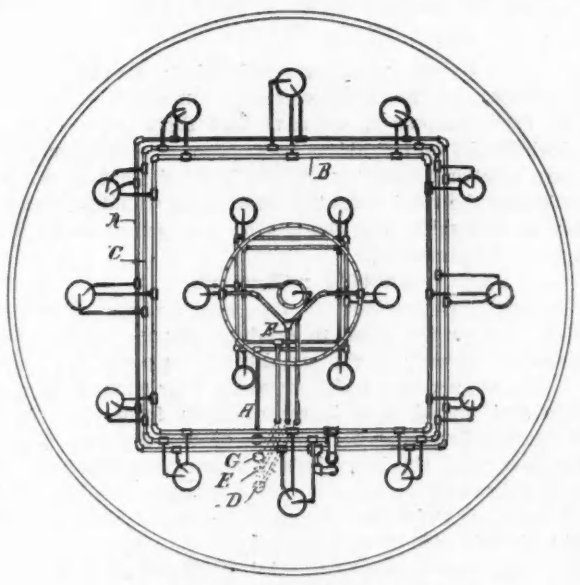
VALVE SIGNAL.

Beneath the color signal box under the fountain is a simple signal testing switch by which any of the lamps in the signal box may be thrown into circuit to test the integrity of the circuits. Over the signal box is located a small electric bell operated by the push button referred to in the tower, by which signals may be given to stand ready to change the colors.

The operation of these signals is as follows: When a change of color is desired, the operator in the tower who overlooks both fountains presses the signal "stand by to change." Supposing he desires to have the central geyser red, the six encircling composites blue and the outside circle yellow, whatever lights had previously been illuminated would be extinguished and the red switched in the centre row, the blue in the one marked 2 and yellow in the one marked 3. This would at once illumine the lamps in the signal box under the fountain which are covered by that colored glass in the vertical rows, and the operator there would move the color screens accordingly. In our sketch the color signal indicates green for the central geyser, yellow for the surrounding six and red for the outside circle of twelve.

VALVE SIGNALS.

Scarcely less important than the changes in color are the changes in the jets of water issuing from the various pipes. By combining these two sets of changes only a calculation by permutations can give an idea of the variety of effects which may be produced by such a fountain as this. Some of these have been already described in our article on the "Construction and Operation of Electric Fountains," published on page 42 of The Electrical World for Jan. 21, and need not be repeated here. Included in that article was a description of these same fountains which was, as far as it went, very nearly correct, and has remained to this date the best description published. For the valves there are a separate set of signals operated in the same way. As has been shown by our sketches, the valves controlling the various groups of jets are arranged in two rows facing each other near the entrance to the caisson. At one end of the passageway, between these two rows of valves is the valve signal box, which is similar in principle to the one just described. It consists of a box with two horizontal rows of compartments each containing an incandescent lamp as before, and each covered with a ground glass pane marked in black with the number of the valve and the words "Project" and "Pulsate." To fill out the box, one compartment is left blank as shown. As before, the signal is given by illuminating the lamp in the appropriate compartment, and when the compartment marked "Pulsate" is illuminated, it indicates that the operator is to move the particular valve back and forth so as to give the jets under control a pulsating motion. The word "Project" appearing indicates that the valve is to be opened suddenly so as to give an explosive or rocket effect. This is much heightened by at the same time producing the water hammer in the pipes by suddenly closing another valve at the same instant. Beneath this signal box is another switch for the purpose of testing the signal circuits and an electric bell also forms a part of this signaling apparatus as with the color signals, and is used for the same purpose. An electric push button is also at hand connecting with the pumping engines by which the valve operators may communicate their



SCHEME OF JET SUPPLY PIPES.

demands on the pumps. The code of signals for this purpose is given under the description of the pumps. In addition to all these signaling devices there is telephonic communication between both of the fountains and the controlling tower, by which more elaborate directions than are possible by mere signals can be transmitted.

In the signal tower the valve signals are given through the General Electric Company's standard marine signal box.

ELECTRICAL CONNECTIONS.

To the right of the entrance as one looks toward the west is the switchboard controlling the arc light circuits, which consists of a very neatly finished hard rubber board upon the face of which are located an ammeter and voltmeter, ten double pole switches and ten single pole switches and an equal number of rheostats.

As in the water and color control, the central geyser also has its own individual electrical control, and for this purpose one double pole and one single pole switch and a special rheostat are provided. The other lamps are all controlled in pairs, as they are so arranged in series across from the middle to one or the other of the outside wires of the three-wire system which is adopted throughout. To each pair of lamps one of the nine remaining double and single pole switches and rheostat is connected. The double pole switch is for the purpose of throwing in or out of circuit the pair of lamps to which it is assigned, and the single pole switch is for the purpose of connecting that pair of lamps with the ammeter when desired.

There are in each of the fountains the same number of circuits, and all the circuits run around the chamber in the same way and are the same length with each other to an inch. Each circuit also runs entirely around the chamber, and by these resorts the drop is equalized and the two sides are maintained in almost perfect balance.

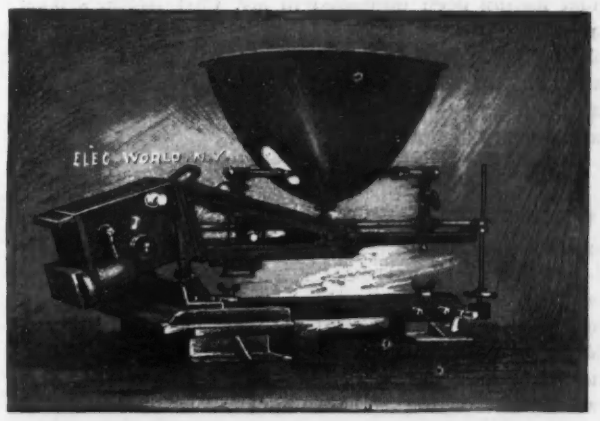
In assigning the credit for the provision of this most magnificent spectacular display we come face to face with a difficulty beside which all others involved in the preparation of this article are paled into insignificance. It is the joint work of so many that we hesitate to mention any for fear that in so doing we may appear to slight others. There are a few names, however, which in our study of the subject have become more familiar than the rest, and these we may mention with the single qualification that were the work of any one of them omitted from the task the work as a whole would be other than it is.

The general plan of these fountains is not new. We believe they were first worked out and patented in England by Sir Francis Bolton. Mr. W. Dwight Wiman purchased the patents for the United States for his father, Erastus Wiman, and to him is due the credit of first introducing them to this country; but the details of these particular fountains had to be worked out for the occasion and here is where we meet our difficulty in the division of credit. In this work Mr. Luther Stieringer has been most prominent, and perhaps to him is due the chief credit for the first inception of this display and its successful completion. Without the active co-operation of Chief Burnham and Mr. F. Sargent their completion would have been impossible. Mr. E. R. Knowles, of the Schuyler Electric Company, should have the credit of the electrical adaptation of existing apparatus to this special purpose and the designing of the signaling systems, and the General Electric Company through its Schenectady, Lynn and Schuyler Electric Company plants the credit for manufacture. Lieut. E. J. Spencer as the special agent of the contractor and through his own personality has contributed much to the success of the enterprise, and to his wise administration of this much of the great responsibility entrusted to him is due the harmony of action of the constituent factors in the work. Mr. C. A. Chase, of the Schuyler works, has had special charge of the electrical construction on the ground, and to him and to Mr. Dorr, who has had charge of the mechanical part, full praise is accorded.

The American Institute of Electrical Engineers

The annual meeting of the Institute for the reception of yearly reports, election of officers and other business proceedings will be held at the headquarters of the institute, 12 West Thirty-first street, at 4 p. m. on Tuesday, May 16, and will probably occupy two and a half hours. After adjournment, those so desiring will assemble at the Atena, 41 West Thirty-first street, where it is hoped that all will find it convenient to meet in a purely social gathering. The general meeting will be held at the Institute headquarters on Wednesday, May 17. The morning session will be called together at 10 o'clock, and the following papers will be read: 1. "On the Behavior of Fuse Metals in Direct and Alternate Current Circuits," by Mr. Charles P. Matthews, of Cornell University, Ithaca, N. Y. 2. "A Modified Deprez d'Arsonval Galvanometer," by Lieut. Charles D. Parkhurst, of Watervliet Arsenal, West Troy, N. Y. 3. "The Variation in Economy of the Steam Engine Due to Variation in Load," by Prof. R. C. Carpenter, of Cornell University, Ithaca, N. Y. 4. "An Automatic Printing Speed Counter for Dynamo Shaftings," by Prof. Geo. S. Moler, of Cornell University, Ithaca, N. Y.

At 1 p. m. a recess of one hour will be taken, and a collation served. At the afternoon session papers will be read as follows: 5. "Practical Aspects of Electrical Resonance," by Dr. M. I. Pupin, of Columbia College, New York City. 6. "The World's Electrical Congress of 1893,"



THE PROJECTOR LAMP.

Discussion of the Provisional Programme prepared by the Institute Committee. This report, with its appendices, has been printed in the January and February issues of the Transactions, and absent members are earnestly invited to contribute in writing any comments they desire to make. 7. "High-Tension Generators for Direct Current Transmission," by Prof. Francis B. Crocker, of Columbia College, New York City. 8. "The Heating of Armatures," by A. H. and C. E. Timmerman, of Cornell University, Ithaca, N. Y.

The First Week of the World's Fair.

The attendance during the first six days at the World's Fair has not been as large as was anticipated, but this is, no doubt, due in a large measure to the very bad weather, and to the fact that it is pretty widely known that the exhibits are not yet in a completed condition. About one-quarter of a million people paid admission during these six days, which exceeded the number for the corresponding dates at the Philadelphia Centennial. The grounds were not open to the public on Sunday, and it is estimated that nearly 150,000 people applied for admission, a considerable proportion of whom, after being turned away, sought amusement in the various outside shows and exhibitions—a strong argument against closing the Exposition on the Sabbath.

On Monday evening there was a partial illumination of the grounds for the first time. The exterior and interior illumination of the dome of the Administration Building was particularly fine. The gas flambeaus on the colonnade of the dome, however, seemed out of place among so many electric lights. Most of the embankment lights and those on the cornices of the peristyle were illuminated, with beautiful effect. The electrical fountains are not yet completed, nor were the search lights brought into play.

Alternating Current Motors.

BY C. E. L. BROWN.

Mr. Arnold in his last article attempts to treat my work on alternating current motors, dating, as it does, from 1891, as having been anticipated. For example, he mentions a patent of Tesla, of which he must be well aware that a machine built in such a way would not work. He further wishes it to be believed that the hole wound armature was invented by Wenstrom, whereas he must know, first, that Wenstrom never patented a hole wound armature, but one with slots; and, second, that the use of the hole armature for multiphase motors was first proposed by me.

He further says that the single-phase motor is the natural consequence of the development of the multiphase motor, and this is certainly more or less the case. But he seems to quite forget whence these improvements came, and overlooks the fact that this development was, after all, not such a very natural one, as Mr. Dobrowolsky for example, in a letter to the "Electrotechnische Zeitschrift" disputes the possibility of producing a good practical single-phase motor, although he has been building multiphase machines for some years.

The position taken up by Mr. Arnold in refusing to see anything new in my method after he has heard about my results is certainly easily understood.

BADEN, April 26, 1893.

Practical Rule for Determining the Direction of Currents in Dynamos.

Mr. Heinrich Kratzart writes us from Vienna, giving a very simple practical rule, which he claims as original with himself, for determining the direction of the currents in the armature of a dynamo which is equally well applicable to bipolar and multipolar machines as also to rotary current machines. The rule is as follows: If the armature revolves to the left, the direction of the current in the portions of the windings on the ends of the armature will be the same as the direction of the lines of force; or in other words the lines of force and the electric current will have the same direction in looking at the end of the armature; if the armature revolves to the right the current and the lines of magnetic force will have relatively opposite directions. This rule of thumb is certainly very simple and is well worth the attention of those who have to do with dynamos. As to its supposed novelty, however, Mr. Kratzart is mistaken, as he has been anticipated, though doubtless without his knowledge, by more than seven years, precisely the same thing having been published in Mr. Carl Hering's book on "Dynamo Electric Machines," page 44, in which the following rule is italicized: "If the rotation is opposite to that of the hands of a watch the current at that end will have the same direction as the lines of force." In a motor this rule must be reversed.

Trade Advertisement at Technical Societies.

We never know, says London "Industries," quite how far the straightforward system of advertisement adopted in America is to be commended or condemned. For instance, we recently received a copy of a paper read before the American Institute of Electrical Engineers on "Micanite." It is a trade prospectus pure and simple, and is followed by a discussion. Recently, again, there was a paper on the Thomson joulemeter, or wattmeter as it is termed in the United States. In this country we have trade circulars too; but we frequently "assume a virtue when we have it not," and disguise the circular under a thin veil before bringing it before a scientific or technical society. When an English firm desires to push a new insulating material, made, say of mica and cement, or a meter which is devoid of any scientific originality whatever, one of its members reads a paper on "The Dielectric Properties of the Earth Silicates," or "Electrodynamical Means of Integrating Electrical Power," and their goods are thus advertised successfully. The American method is at least more straightforward, though perhaps less dignified.—London Electrician.

Conductors and Insulators.—V.

BY REGINALD A. FESSENDEN.

Suppose now, after having made these premises, that the two plates of copper in the solution are given a definite charge, one of positive, the other of negative electricity. The positive charged ions of copper will as before, be driven and attracted to the copper plates. But the attraction to the negative plates will be stronger than that to the positive, so that on the whole more will unite with the negative plate than before, and less with the positive. But the collidings of the copper atoms in the electrode plates will drive very nearly as many atoms (belonging to the plate) into the solution as before. The state is not one of equilibrium, as before, so the positive plate will go on losing atoms, and the negative gaining, till the charges are all dissipated. This will occur for the negative plate when the sum of the charges on the positive copper ions is numerically equal to the charge originally given to the negative electrode, and similarly for the positive plate and the negative SO_4 ions.

The number of ions necessary to effect this neutralization may be easily found. It will be sufficient to find a superior limit, however. Suppose that the battery jar holds one litre; the solution contains 100 grammes of copper sulphate, and the electrodes are 10 centimetres square and 1 millimetre thick, placed parallel to each other, and 10 centimetres apart.

The capacity of the plates will be less than 5×10^{-11} farads.

From chapter I. we saw that the charge on a single atom was equal to 10^{-20} coulombs, approximately. As the size of an atom is about 10^{-8} centimetre (in diameter) its capacity will be rather more than

$$\frac{10^{-8}}{18 \times 10^{11}}$$

or, say, equal to 10^{-20} farads, and the potential on each atom approximately about one volt, more or less, depending on the size of the atom.

This being the case, suppose the electrodes to have been charged to a potential of 1,000 volts. The amount of electricity on each will be equal to 5×10^{-8} coulombs, approximately. It will take therefore

$$\frac{5 \times 10^{-8}}{10^{-20}} = 5 \times 10^{12}$$

atoms to be deposited on each plate in order that the charges on the latter may be neutralized.

As from chapter I. we saw that there were in the neighborhood of 10^{23} atoms in a gramme of matter (the exact number depending on the kind of matter), it appears that the total weight of ions which would be necessary to neutralize the charges on the plates would be about 10^{-11} gramme or

.00000001 milligramme,

a quantity inappreciable to the most delicate chemical tests, and far too small to produce any measurable increase or decrease in the weights of the plates.

As the copper ions which gave up their charges to the plate and united with it were drawn from that part of the solution lying next to the plates, we may calculate how thick the layer is which has been deprived of its copper ions.

Since the molecular weight of copper sulphate is (63 + 32 + 64) and the atomic weight of copper is 63, in the 100 grammes of copper sulphate dissolved in the solution there will be 40 grammes of copper. As the specific gravity of copper is 8.9, this will equal 4.5 cubic centimetres. As the atomic volumes of silver and copper are in the ratio of 10 to 7, this volume of copper will contain 6.4 times as many atoms as a cubic centimetre of silver does, or 6.4×10^{24}.

Therefore the thickness of the layer occupied by the 5×10^{12} upper ions which neutralized the charge on the negatively charged electrode will be (the back of the electrodes supposed varnished)

$$\frac{6.4 \times 10^{24}}{5 \times 10^{12} \times 10} = \text{about } 10^{-11} \text{ centimetre.}$$

A layer this thick is therefore stripped of its ions every time the electrodes are discharged, provided that we assume that all the copper sulphate is disassociated into ions. In our assumption above we took only five per cent. as being in this condition, so the thickness of the layer will be 5×10^{-9} centimetre.

It is evident that no more electrolysis can go on till this layer has a fresh supply of copper ions, and that the amount of current which will pass through the solution with a given voltage, and therefore the resistance, will depend on the quickness with which this layer is replaced. We can easily find out on what the latter depends, from the following considerations:

Looking at the layer just next the negatively charged electrode, when it has had all its positive (copper) ions deposited on the plate, we see that the kinetic energy per unit of volume, and the amount of cohesive force per unit of volume, are necessarily less than in the rest of the solution, on account of the taking away of the copper ions. From the fraction given in chapter II. as determining by its value the state of matter any collection of atoms is in, i. e.,

$$\frac{\text{Attractive force due to cohesion}}{\text{Repulsive force due to kinetic energy} + \text{attractive force of other atoms}}$$

we see that such a state as that existing in the layer is one unfavorable to disassociation.

Consequently, the copper ions belonging to the next layer which penetrate into the layer next to the electrode (layer) will be immediately seized upon by the SO_4 ions in that layer, and will form $CuSO_4$ molecules.

As layer 1 has been stripped of its copper ions by the electrolysis, no ions will pass back (or comparatively few) to layer 2, as they would do were no electrolysis taking place. Consequently the position unfavorable to disassociation is now transferred to layer 2. This in turn draws on layer 3, and so on till finally we reach the layer next the positively charged plate; and as this already contains an excess of positive ions, the state becomes one of equilibrium as at first. The electrolysis can then go on again, and the whole process will be repeated, for so soon as layer 1 has received its lot of positive ions, the condition becomes favorable to disassociation again, and we have a fresh lot of disassociated ions in that and all the other layers of the solution. (It must not, of course, be supposed that the process goes on in any such well defined way as that given. In any one layer all these processes are going on at the same time.)

The time it takes a fresh lot of ions to be prepared at the electrodes will evidently then depend on the time it takes for a copper ion and a SO_4 ion, moving toward each other, to meet. Supposing the copper ion had velocity 5, and the SO_4 ion velocity 1, and they were 12 units apart from each other; then the time taken for the two to meet would be two seconds.

If the copper ion had velocity 11 and the SO_4 the same as before, the time taken would be one second.

The sum of the velocities in the first case is 6, and the time 2.

In the second case the sum of the velocities is 12 and the time 1.

We see therefore that the time taken to produce a fresh lot of ions at the electrodes, and therefore, as shown above, the resistance, is inversely proportional to the sum of the velocities of the ions.

This great discovery is due to Kohlrausch.

In the method here given, on account of positive and negative electricity being considered as independent of each other, it does not necessarily appear why electrolysis should not go on indefinitely when a positively charged plate is dipped alone into the solution. If we adopt any definition of a charge which shows this, it becomes clear. For instance, we may take Faraday's conception of lines of force, as it has recently been beautifully applied and extended by Prof. J. J. Thomson. The following is taken with some (perhaps unnecessary) amplification from his paper on that subject in the "Phil. Mag." of March, 1891:

If the two electrodes are connected to the terminals of the dynamo, as above, we will have lines of force stretching from one to the other.

When they (the electrodes) are dipped into copper-sulphate solution, the lines will still stretch across, and we may call the positive direction of the lines from + to —.

Suppose a molecule of $CuSO_4$ comes near the line, it will set itself so that the plus ion is near the more negative part of the tube of force, and its negative ion near the more positive. The tube of force between the ions of the molecule will then lie in the opposite direction to that in which lies the long line of force between the electrodes.

If it is drawn too near, the long tube or line will break, and its two ends fasten themselves to the ions. If the molecule does not disassociate, after a while it is driven too far out of the way and the tube of force is broken and snaps together again. If, however, it does disassociate, the tube is broken, and if one ion, say the copper one, is near the — electrode, that end shortens to molecular dimensions, and the ion becomes a part of the copper plate. The other part of the tube remains attached to the SO_4 ion, and is presently shortened again, till it finally becomes reduced to molecular dimensions, like the first part.

We can now get a formula for the conductivity. Suppose each time the tube breaks down the two ions travel a total distance d, and they break down n times a second. If u and v are the velocities of the ions, then $u + v = n\,d$.

Let m be the number of molecules per unit area, in a plane parallel to the electrodes, and e the charge on each. The total charge (the molecules are supposed to be strung on tubes of force) is m e, and this is equal to the surface density on the electrodes. As, in a dielectric of specific inductive capacity K, the electromotive intensity at the electrodes $E = \frac{4\pi F}{K}$; where F = surface density we have $m\,e = \frac{K\,E}{4\pi}$.

Multiplying both sides of this latter by n, we have

$$\frac{M\,e\,n}{E} = \frac{K\,n}{4\pi}$$

But m e n, or the number of molecules in unit cross-section, multiplied by the charge on each, and by the number of times they are discharged per second, is equal to the current flowing, so we have

$$\frac{C}{E} = \left(\frac{1}{R} = \right) C = \frac{K\,n}{4\pi},$$

where c = the conductivity of the solution.

If N equals the number of molecules per unit volume we have also $m = N\,d$.

Combining these equations we find

$$u + v = \frac{c\,E}{N\,e}$$

which is Kohlrausch's formula.

This can be translated more easily by writing it

$$\frac{(u+v)\,N\,e}{E} = c = \frac{1}{R}$$

for we see at once that the sum of the velocities of the ions multiplied by the number in unit volume and by the charge on each is equal to the current flowing, so that the above is equal to our old friend $C = E/R$.

This alternative method, while better in some ways, is a little more artificial than the purely physical explanation given first.

We will next see what the results of this motion of the ions are, the methods of rendering this motion visible, and of predetermining the resistances of liquids.

The Calculation of Alternating Current Motors.—III.*

BY E. ARNOLD.

In every alternating current motor with a short-circuited armature the conditions in the armature when at rest or when about to move are quite different from those when the armature is running. I will at first discuss the two conditions separately.

The conditions of a multiphase motor when the armature

The Conditions of a Multiphase Motor When the Armature is at Rest and About to Move.—At that particular moment let the arrows in Fig. 5 represent the direction of the current; there will then be generated a south pole on the right and a north pole on the left. If we assume that the current of phase I is diminishing from a maximum, and that in III is approaching maximum, the poles N and S will be moved in the direction of the bands of a watch.

Let E_1 be the maximum value of the primary E. M. F. between the ends of the windings for one of the phases;

I_1 be the maximum of the primary current of one of the phases;

$p_1 = 2\pi n_1$, in which n_1 is the frequency of the primary current;

L_1 be the coefficient of self-induction of the primary circuit per phase;

R_1 be the resistance of the primary circuit per phase;

φ_1 be the angle of the phase difference between E_1 and I_1;

s_1 be the number of windings of the primary coils per phase;

A_1 be the energy delivered to the armature per unit of time;

E_2 be the maximum value of the E. M. F. induced in one winding of the armature;

I_2 be the maximum value of the corresponding current

$p_2 = 2\pi n_2$ be the angular velocity of the armature winding, in which n_2 is the number of revolutions of the armature per second;

L_2 be the coefficient of self-induction of one winding of the armature;

R_2 be the resistance of one winding of the armature;

s_2 be the number of armature windings;

φ_2 be the angle of the phase difference between E_2 and I_2

A_2 be the energy induced in the armature per unit of time;

H_s be the maximum intensity per square centimetre of that magnetic field which one phase alone would induce;

H_1 be the intensity per square centimetre of the rotating field which is assumed to be homogeneous;

H be the intensity per square centimetre of the resulting effective rotating field, considering the reaction of the armature currents;

f_2 be the area in square centimetres of one armature winding;

M be the maximum value of the coefficient of mutual induction between one phase of the primary winding and one winding of the armature;

D be the torque exercised by the armature.

We will make an assumption that the saturation of the iron cores is so low that the coefficients L_1, L_2 and M may be taken as constant. H_s, H_1 and H represent only those lines of force per square centimetre which really enter the armature. The currents and the electromotive forces are assumed to be a simple sine function of the time. The field intensities H_s may be taken as proportional to the momentary current strength $i_1 = I_1 \sin p\,t$. With the approximately correct assumption that the magnetic forces may be combined in accordance with the law of the parallelogram of forces, we may, in order to find the resulting intensity H_1, resolve the three components H_s into two axes at right angles to each other. We then obtain in the direction of the X axis the sum

$$H_s \sin p_1 t - H_s \cos 60 \sin (p_1 t - 120^\circ) - H_s \cos 60 \sin (p_1 t - 240^\circ) = \frac{3}{2} H_s \sin p_1 t;$$

and in the direction of the Y axis the sum

$$H_s \cos 30 \sin (p_1 t - 190^0) - H_s \cos 30 \sin (p_1 t - 240) = -H_s \frac{3}{2} \cos p_1 t$$

The resultant will then at every moment be

$$H_1 = \frac{3}{2} H \qquad (15)$$

* For the first and second parts see THE ELECTRICAL WORLD Jan. 21, p. 49, and April 8, p. 262, of this article.

The resulting magnetic field has therefore a constant intensity and rotates with the angular velocity p_1.

If the number of phases is in general equal to m, and if the difference of the phases is $\frac{\pi}{m}$ then

$$H_1 = \frac{m}{2} H_s; \qquad (16)$$

as

$$f_2 H_s = M I_1; \qquad (17)$$

therefore

$$f_2 H_1 = \frac{3}{2} I_1 M. \qquad (18)$$

In order to obtain a rotating field of the same intensity H_1, we may therefore suppose the periodic current strengths of the three phases whose maximum value $= I_1$ replaced by a constant current of a single phase, the value of which current is

$$= \tfrac{3}{2} I \qquad (19)$$

and whose windings rotate with the angular velocity p.

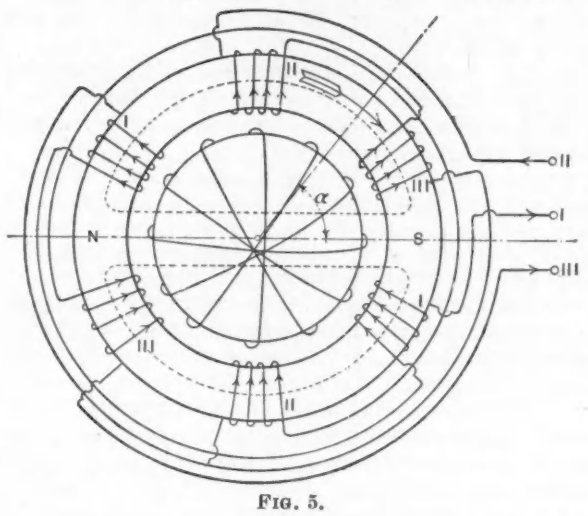


FIG. 5.

The E. M F. induced in one armature winding is

$$e_2 = p_1 H_1 f_2 \sin p\,t. \qquad (20)$$

Taking into consideration the effect of the self-induction, the resulting current will be

$$i_2 = \frac{p_1 H_1 f_2}{\sqrt{R_2^2 + p_1^2 L_2^2}} \sin (p_1 t - \varphi_2). \qquad (21)$$

The energy absorbed per unit of time in *one* armature winding is equal to half of the product of the maximum of e_2 and i_2 and the cosine of the phase difference

$$A_2 = \frac{E_2 I_2}{2} \cos \varphi_2$$

in which

$$\cos \varphi_2 = \frac{R_2}{\sqrt{R_2^2 + p_1^2 L_2^2}}$$

therefore

$$a_2 = \frac{1}{2} \frac{p_1^2 H_1^2 f_2^2}{(R_2^2 + p_1^2 L_2^2)} R_2. \qquad (22)$$

For s_2 windings we obtain, for the total energy absorbed by the armature per unit of time,

$$A_2 = \frac{s_2}{2} \frac{p_1^2 H_1^2 f_2^2}{R_2^2 + p_1^2 L_2^2} R_2. \qquad (23)$$

This must be equal to that energy which must have been

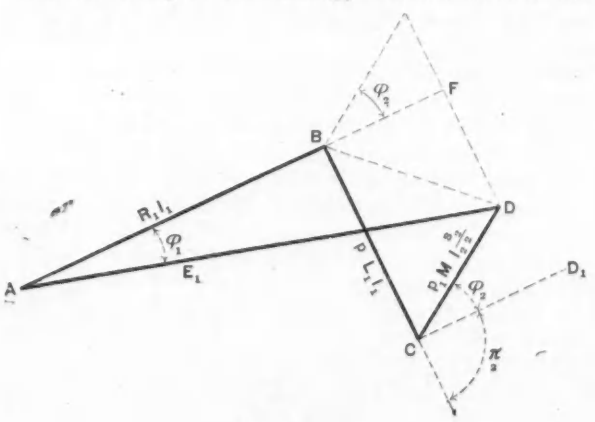


FIG. 6.

used up to rotate the armature with the angular velocity p_1 in the assumed stationary field of the constant intensity H_1. We find from this the torque which is exercised on the armature and which also has a constant value, if we divide the expression given above for A_2 by p_1,

$$D = \frac{s_2}{2} \frac{p_1 H_1^2 f_2^2}{R_2^2 + p_1^2 L_2^2} R_2; \qquad (24)$$

or, if the value of $H_1 f_2$ from equation (18) is inserted,

$$D = \frac{9}{8} \frac{p_1 I_1^2 M^2 s_2}{R_2^2 + p_1^2 L_2^2} R_2. \qquad (25)$$

If the self-induction of the armature is small, we may make

$$D = \frac{9}{8} \frac{p_1 I_1^2 M^2 s_2}{R_2}. \qquad (26)$$

In the same way we may arrive at another result. For this purpose let us first determine the relation of the primary E. M. F. to the other E. M. Fs. There are three E. M. Fs. which keep E_1 in equilibrium:

1. The E. M. F. which the current I consumes in the resistance R_1, whose maximum value is equal to $R_1 I_1$.

2. The E. M. F. of the self-induction of the primary current, whose maximum value equals $p_1 L_1 I_1$. We must assume that the E. M. F. of the self-induction is made up of three parts: one part is induced in the parts of the circuit external to the motor, the second part induced by the dispersion of the lines of force in the motor itself, and the third induced by the rotary field H_1.

3. The counter E. M. F. designated by E_c, induced by the armature current; its value may be determined as follows:

The rotating field H_1 induces in the windings of the armature (which is assumed to be stationary) alternating currents whose maximum value equals I_2; each of these windings therefore generates a periodic magnetic field whose maximum intensity equals h. The number of windings equals s_2, and the angle between the planes of two windings equals $\frac{\pi}{s_2}$; the phase difference between the magnetic fields h is therefore also equal to $\frac{\pi}{s_2}$. These periodic magnetic fields h give as a resultant a second rotating field, which, according to equation (16) has the constant intensity

$$H_2 = \frac{s_2}{2} h. \qquad (19)$$

This field makes a complete revolution with the angular velocity p_1 during the time of one period. It lags behind the rotating field H_1 by an amount equal to $\frac{\pi}{2} + \varphi_2$, and induces in the primary circuit the counter E. M. F.

$$e_c^2 = p_1 H_2 f_2 \sin \left[p\,t - \left(\frac{\pi}{2} + \varphi_2 \right) \right]; \qquad (20)$$

but as

$$f_2 h = M I_2,$$

therefore

$$f_2 H_2 = \frac{s_2}{2} M I_2. \qquad (21)$$

We may therefore suppose that the magnetic field H_2 is generated by a constant current of the value

$$I_0 = \frac{s_2}{2} I_2, \qquad (22)$$

which may be imagined to flow in a single armature winding which always makes an angle φ_2 with the direction of the rotating field H_1. As a matter of fact, there will not be two rotary fields, H_1 and H_2, as both will combine into one resulting rotating field of the intensity H.

From the equations (20) and (21) the maximum value of the counter E. M. F. will be

$$E_c = \frac{s_2}{2} M I_2 p_1. \qquad (23)$$

In Fig. 6 let $R_1 I_1$ be laid off equal to A B; perpendicular to the same lay off the E. M. F. of self-induction $p_1 L_1 I_1 = B C$. On the continuation of B C lay off the angle $\frac{\pi}{2} + \varphi_2$ and make

$$\frac{s_2}{2} M I_2 p_1 = C D;$$

then the closing line A D will give the maximum value of the primary E. M. F. in direction a value, and the angle B A D will give the angle φ_1 of the phase difference between E_1 and I_1.

The energy delivered to the motor per unit of time is

$$A_1 = \frac{3}{2} E_1 I_1 \cos \varphi_1. \qquad (24)$$

The power consumed in the primary circuit $= \frac{3}{2} R_1 I_1^2$, and the power induced in the armature

$$A_2 = \frac{s_2}{2} R_2 I_2^2; \qquad 25$$

therefore

$$\frac{3}{2} E_1 I_1 \cos \varphi_1 = \frac{1}{2} (3 R_1 I_1^2 + s_2 R I_2^2) \qquad (26)$$

But the power consumed by the armature is also equal to the primary current $\frac{3}{2} I_1$ multiplied by the projection of the counter E. M. F. on the direction of this current:

$$A_2 = \frac{3}{2} I_1 \frac{s_2}{2} M I_2 p_1 \cos \varphi_2. \qquad (29)$$

From the equations 18 and 20 it follows that

$$E_2 = \frac{3}{2} p_1 M I_1; \qquad (30)$$

therefore

$$I_2 = \frac{3}{2} \frac{p_1 M I_1}{\sqrt{R_2^2 + p_1 L_1^2}}. \qquad (31)$$

Introducing this value as also the value of $\cos \varphi_2$ in equation (29), we obtain, as before,

$$A_2 = \frac{9}{8} \frac{p_1^2 M^2 I_1^2 s_2}{R_2^2 + p_1^2 R_2^2} R_2; \qquad (32)$$

$$D = \frac{9}{8} \frac{p_1 M^2 I_1^2 s_2}{R_2^2 + p_1^2 R_2^2} R_2. \qquad (33)$$

The losses by hysteresis and Foucault currents, and their effect on the shifting with the phases through the angles φ_1 and φ_2, as also the reaction of the armature current on the rotary field, which diminish the same and turn them in the opposite direction to the rotation, were not taken into account.

(To be continued.)

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

ELECTRO-PHYSICS.

Alternating Current Phenomenon.—Mr. Maicillac, in "La Lum. Elec.," April 22, describes the following experiment which he believes confirms to some extent statements made by Mr. Tesla regarding the effect of surfaces. A small Geissler tube, 4 to 6 inches long, has one end connected to one pole of an ordinary Ruhmkorff coil, while the other end has the platinum wire filed off close to the glass, the second pole of the induction coil being disconnected and insulated; below the free end of the tube is placed a porcelain dish insulated by a plate of ebonite placed on a large plate of glass; the end of the tube is then lowered until it touches the liquid; if then the finger of the hand is touched to the liquid the tube will glow; if after the light is once established the finger be withdrawn the light will diminish, but will still continue; if then while thus disconnected from the water the hand is brought near to the free end of the tube the luminosity will remain almost as intense and will have the same rapidity of vibration; if the end of the tube is then again lowered into the liquid the luminosity will continue. Numerous different liquids were tried with the same result. The experiment may be performed very easily and requires but an ordinary Ruhmkorff coil and a few small batteries. It is very important, however, that the spring of the vibrator is very thin and elastic and that it vibrates like the wings of certain insects, like the dragon fly, for instance, rather than like the blows of a hammer. As this experiment requires only such apparatus as every physicist has, he suggests this as a simple way to show on a small scale some of the Tesla phenomena.

Modification of Ohm's Law.—Mr. Sandford writes to the Lond. "Electrician," April 21, in reply to the criticism of that journal concerning his experiments in which he had claimed to show that the resistance of a wire varies with the nature of the dielectric surrounding it. To show that the difference in resistance is not due to temperature he made a large number of tests with different current strengths and found that in every case the results were the same, which would not have been the case if the differences were due to changes of temperature. Furthermore, ether or petroleum vapor increases the resistance of copper while it decreases that of silver; the resistance of copper was moreover greater in every liquid, except in petroleum, than it was in air. In explaining the title of his paper he said he was not aware that Ohm's law is supposed to apply to a conductor only when its physical state has been kept unchanged.

Collector of Atmospheric Electricity.—Mr. Palmieri, in "La Lum. Elec.," describes an apparatus (reprinted and illustrated in the Lond. "Electrician," April 21), for collecting atmospheric electricity. It consists essentially of a revolving wheel having eight spokes, but no rim; each spoke is made of a conductor insulated from the hub and having a small metallic cross-arm at its farther end; near the hub are arranged two brushes, one above and one below the centre; these brushes are always in contact with the spokes pointing vertically upward and vertically downward respectively, during the revolution, and therefore lead off from them the electric charges collected from the atmosphere at the top and at the bottom of the wheel; the brushes are connected by wires to two Leyden jars and to sparking knobs as usual.

MAGNETISM.

Magnetization of Iron Rings.—In a mathematical paper, published in Wied. Ann., No. 3, 1893, of which a short abstract is given in the Lond. "Elec. Rev.," April 21, Mr. Lehmann describes his investigations with iron rings slit in a radial direction; the results made with a ferromagnetic ring, the radius of which is large in comparison with the radius of the section, are as follows: The demagnetizing factor, or the factor which when multiplied by the mean magnetization gives the mean factor of the demagnetizing force, is constant up to about half its saturation; the coefficient of dispersion, or the ratio of the mean induction to that in the slit, is constant up to half the saturation; the region of the dispersion of the lines is limited chiefly to the vicinity of the slit and is narrower as the magnetization increases; the coefficient of dispersion is independent of the radius of the ring, and its constancy depends only on the relative width of the ring; the empirical expression for the dependence is a linear one containing a certain constant; when the value of this constant is known the factor of demagnetization can be calculated from the geometrical dimensions; for Swedish iron the constant is 7 and that for iron used commercially does not differ widely from this.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring the Power in Three-Phase Circuits.—In Mr. Snell's paper referred to under "Alternating Current Motors," he states that when all three circuits are equally loaded the power can be measured by one wattmeter, placing the current coil in one of the mains and taking two readings, one with the fine wire coil connected to that main and to one of the others, and a second reading when connected to that main and the third one; the power will then be equal to the sum of the two readings; if the load be unequally distributed two wattmeters are required, the current coils being placed in two of the mains and the fine wire coils of each being connected to that main and to the third; the power will then be the sum of the two readings.

Astatic Galvanometer.—The description of the galvanometer of Du Bois and Rubens, referred to in these columns in the issue of April 22, is contained in full in the Ann. der Physik u. Chemie No. 2, 1893, where considerable data is given. The deflection in scale divisions per microampere, the distances of the scale being 2,000 divisions and the full period of swing 10 seconds, is 800, while the best value in Prof. Ayrton's table of other galvanometers is 413; its sensitiveness is therefore nearly double.

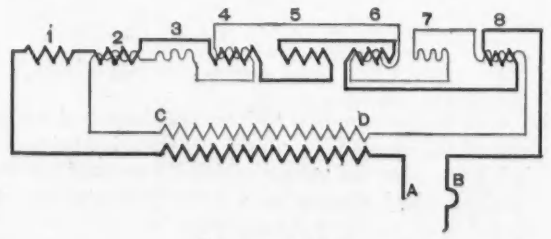
Portable Photometer.—The photometer, mentioned last week, will be found described in the Lond. "Elec. Eng.," April 21, where in addition to the description a few well selected illustrations are given.

Wattmeter.—In the city of London station a wattmeter of the Elihu Thomson type has been installed recently having a capacity of 2,000,000 watts.

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternating Current Motor.—Mr. Snell's paper, of which an abstract was given last week, is continued in the Lond. "Elec. Eng.," April 21. (Also given in part in the Lond. "Electrician," April 21.) The present portion is devoted entirely to the three-phase or rotary field currents and forms probably one of the best summaries which have been published of this subject. It is fully illustrated with numerous diagrams and is of a practical rather than a theoretical nature. To abstract it might be to do injustice to the author as the article should be read in its entirety. He discusses a number of important points, among which may be mentioned the comparison of what are known as the open and closed circuit connections or the "star" and "triangle" arrangements, as they are often called, and gives some data regarding the relations of the currents and voltages; a method of measuring the power is given in another column under "Measurements." Regarding the motor he says that since the total magnetism decreases as the armature current increases, there is a point at which the torque is a maximum; this corresponds to a definite current which is not the starting or the maximum current, and hence those motors do not exert their greatest effort at starting; if the armature reaction is sufficiently small the greatest torque might be obtained at starting; he thinks the maximum effort could be obtained with a slightly greater current than that required for the greatest output. He thinks that if multiphase currents come into general use the diphase will be used for combined light and power distribution, and that the three-phase currents may find their field of usefulness in the transmission and distribution of power. He also gives the results of a number of experiments, in the form of curves, with a generator and motor, which, however, were unfortunately built under unfavorable circumstances; the results, however, are interesting and instructive, and are recommended to those interested in this subject. The paper is to be continued.

Starting Alternating Current Motors.—"La Lum. Elec.," April 22, describes and illustrates an apparatus devised by Mr. Brown, by means of which the current in starting an alternate current motor may be regulated. It consists essentially of a transformer whose primary and secondary are identical except that the latter is divided into a number of sections connected to a switch which enables one or more of these sections to be used for furnishing the current for the motor; at starting, only one section is used, the others being switched in as the



Rotary Field.

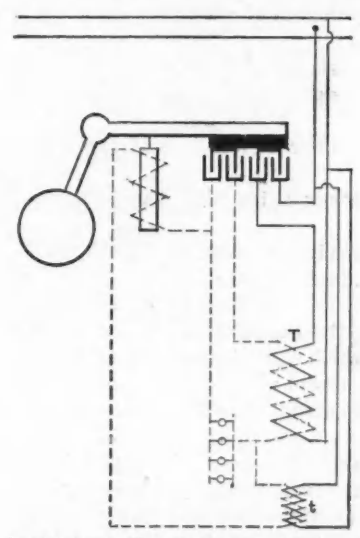
speed of the motor increases; if a comparatively large current is required at starting the first sections may be made of thicker wire. If the motor is to be run directly from the mains a similar sectional winding is used, but arranged as a choking coil, the current from the mains passing through all the sections in series, while that for the motor is branched off from one or more of the sections. In the latter arrangement the choking coil may contain a secondary coil, the current from which, at low tension if desired, may be used for excitation; by placing a secondary coil on this same choking coil, connected in series with the armature, the motor may be compounded. The arrangement is applicable also to multiphase currents in which case it is duplicated for each phase; in some cases it would be sufficient to change by means of switches from the triangle or closed circuit system to the star or open circuit system.

Rotary Field.—In a German patent, Mr. Wahlstroem describes the following method for obtaining from a single alternating current a rotary field, which is as nearly as possible of constant intensity. In the accompanying figure the circuit A B is connected directly to the mains of an alternating current source; the secondary circuit C D differs from it in phase by 90°; the successive coils 1, 2, 3, etc., wound as shown, will then develop a rotary field of nearly constant strength; the field is bipolar, and the two poles will be four coils apart from each other; the phase difference between two successive coils will be about 45%; in order that the double coils through which both currents pass do not develop more lines than the others, their number of windings is made proportionately smaller. (Attention is also called to a similar principle, illustrated and described in The Electrical World, Sept. 19, 1891, page 194.)

Dynamos.—The colossal dynamo recently built by the Oerlikon Company for the production of aluminium is illustrated in "L'Electricien," April 15. It is one of the largest dynamos ever built, and has a capacity of 7,500 amperes at 55 volts, or about 600 h. p., running at 150 revolutions; it has 120 brushes; its axis is vertical, it being coupled directly to the turbine.

Transformer Regulations.—The British Board of Trade, in establishing rules to prevent the possibility of a low tension circuit from coming in contact with the high tension circuit, requires that the two windings in the transformer, or any portion of the same, must be separated from each other by a wire or other conductor possessing sufficient sectional area, which is connected to earth, but is not in metallic connection with either of the two circuits.

Automatic Transformer Switch.—Mr. Bachmann, in the "Elek. Anzeiger," March 26, describes the following switch, which automatically breaks the primary and sec-



Automatic Transformer Switch.

ondary circuits of a transformer when the last light is cut off, and closes the circuit as soon as the first light is turned on. T is the main transformer; t is a small transformer of only 5 watts capacity, whose secondary is connected, as shown, in parallel, with that of the main transformers. When the last lamp is turned off, the current through the solenoid S is broken, which then releases the lever switch, opening the circuits; when the first light is turned on, the current from the smaller transformer actuates the solenoid S, which in turn closes the circuits for the large transformer. A similar instrument is described and illustrated for putting in and out of circuit, one after the other, a number of transformers in parallel, in proportion to the load required.

ARC AND INCANDESCENT LIGHTS.

Projectors.—The Lond. "Electrician," April 21, reprints an article from the German, by Mr. Nerz, on the construction and uses of projectors. The article is ably written, is thoroughly practical, and contains some useful formulas regarding parabolic mirrors. It is illustrated with a number of cuts. It is favorable to the Schuckert projector, whose qualities it is intended to bring out. The efficiency of a projector, he says, depends on the size of the "useful angle"; that is, the angle subtended by the reflector from the light as a centre; the efficiency depends also on the capacity to transmit the light collected with a minimum loss. He describes the well known Fresnel lenses, now used largely for lighthouse purposes, built up of concentric rings, each of which is a portion of a lens, and surrounded with rings acting as total reflectors, in order to collect the light for the outside of the lenses. Although these lenses are largely used, they are difficult to construct with the necessary accuracy. The Mangin projector is a spherical concave mirror, whose inner surface has its centre of curvature nearer the mirror than the outer reflecting surface; the deviation from parallel reflection is thereby almost entirely eliminated when the diameter of the mirror is not greater than its focal length; its useful angle is about 60°; an attempt to increase this angle to 100° by placing lenses between

the light in the mirror was tried, but abandoned. Tschikolew made approximately parabolic mirrors, built up of rings, but they were found to be inferior in general to the Mangin. Schuckert lately succeeded, by a special process, in making parabolic mirrors of one piece of glass. If, in these, the source of light is a point, the light will be reflected as a perfectly cylindrical beam, and, were it not for absorption, the beam would extend indefinitely without any diminution of intensity, and at all points the beam would have a constant diameter; a true shadow picture in such a beam would be projected to any distance; if the focal length is shorter, the mirror could be smaller and the beam more intense. As all other mirrors are only approximations to the true form, the beam is slightly conical and therefore diminishes in intensity with the distance, proportional to the increase in the area of the beam. As there is no such a thing as a source of illumination confined to one point, the size of the source must be taken into consideration, and this will, even in a true parabolic mirror, produce a slightly diverging beam; every luminous point of this source produces a cone of light whose axis is parallel to that of the mirror; the intensity of the beam will therefore be greatest in the centre, and least toward the outside; objects near the projector, therefore, cast no shadow. He gives a simple formula for determining the amount of light in the beam in terms of the dimensions of the apparatus, together with some deductions, among which is a formula for the ratio of intensification or the increase in illumination due to the projector. If the useful angle is the same for different sizes of mirrors, then the intensity of ilumination attained at any given distance is proportional to the square of the diameter of the mirror. Comparing a Mangin and a parabolic reflector of equal diameter and of focal lengths of 42 and 25 centimetres respectively, he finds that the useful angles are 83° and 124° respectively, showing that the amount of light gathered by each is as 1 to 2.11. (Although this shows a gain of 100% for the parabolic reflector, it does not necessarily apply to an arc light projector, in which most of the light comes from the crater, and is therefore not necessarily greater in amount the larger the useful angle.)

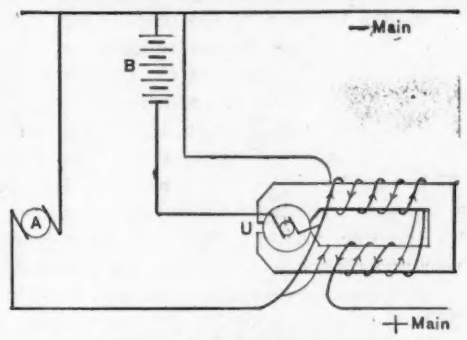
Blackening of Lamp Bulbs.—Referring to this subject, Lond. "Industries" suggests that it may be explained by the assumption that hot carbon slowly volatilizes considerably below its melting point like camphor; it also offers a suggestion that it may be due to the difference of potential between the legs of the filament, causing currents to pass across the space, hot, rarefied gases being good conductors, and that these currents cause the carbon to leave the filament and to be deposited on the glass.

Waterhouse Arc Lamp.—The Lond. "Elec. Rev.," April 21, gives a short description of this lamp, accompanied by a number of illustrations.

Portable Lamps and Accumulators.—The Lond. "Electrician," April 21, illustrates a system at present being introduced in London known as the "Zenith." The accumulators are of the Faure type of a modified construction. The battery for a pocket lamp weighs 12 ounces, and is stated to run 10 hours, the lamp giving 1 c. p. of light, and is fitted in an imitation watch case arranged for the pocket. A battery for three lights in an omnibus weighs 30 pounds. In London alone, about 500 omnibuses are either completed, or in course of completion, with these lights; the lamp cases are 15 inches in diameter, having 12 inch reflectors; the reflector is arranged as a patented advertising device, the income from which enables the lights to be supplied at a low figure; the battery company supplies the omnibus company with the entire outfit at a small weekly rental, and renews the accumulators at certain stoppage points of the omnibuses; for bicycles they make an 8-volt accumulator, fitted in a leather case, enabling the lamp to be placed on any part of the machine.

INSTALLATIONS, CENTRAL STATIONS, ETC.

Accumulator Installations.—Under the heading of "Electrical Distribution," the Lond. "Elec. Eng.," April 21, describes an interesting and ingenious device designed by Messrs. Crompton and Chanen, to overcome the difficulties due to the varying voltages in charging and discharging accumulators. It is shown in the accompanying figure, in which A is the main generating dynamo for 100 volts, and U the so-called "up-down" dynamo, which is coupled in series with the battery B for 100 volts, and is capable of giving at a moment's notice about 12 volts in either direction, according to the demand made upon the mains. The field of this dynamo is wound, as shown, with two windings; one, an ordinary shunt sufficient to excite the magnets so as to generate fully 12 volts in one direction, namely, in the direction for charging the cells; the other winding being very heavy and in the opposite direction to that of the shunt so that the currents in the two oppose each other; if the current in the coarse winding is sufficient in quantity, it can entirely reverse the effect of the shunt and generate 12 volts in the other direction; namely, that for discharging. When there is no demand on the mains there will be no current in the coarse winding, and the up-down dynamo will generate 12 volts to assist the current from the main dynamo to charge the battery; if the current in the mains is equal to the capacity of the main generator, the up-down dynamo will generate no volts at all, as the two windings neutralize each other, and there will, therefore, be practically no current in the battery circuit; if the cirrent in the mains increases beyond the capacity of the main dynamo, this current in the coarse circuit will reverse the polarity of the up-down dynamo, so that it gives up to 12 volts in the other direction, and assists the accumulators to discharge, thus keeping the load of the main dynamo down to its maximum capacity. An arrangement is also suggested in which this same principle is applied to a long railway circuit by distributing the energy to different places along the line, where it remains stored up in batteries until required by a passing train; the descriptions and illustrations are, however, not very



ACCUMULATOR INSTALLATION.

clear. The method may be modified to suit charging a distant battery station for lighting and other purposes, from a feeder or even from a network, without raising or interfering with the normal voltage of that feeder; in these cases, the up-down dynamo may be driven by an electric motor.

Economy of Electric Supply.—Mr. Kapp recently read a paper on "Some Economic Points in Connection with Electric Supply," the first part of which is given in the Lond. "Elec. Eng.," April 21. The article is intended more particularly for persons intending to introduce electric light in their houses, and contains a number of points which are well worth the consideration of such persons. Among other things he points out the defects of the usual method of giving the contract to the lowest bidder without consulting an unbiased engineer; the result of this method is invariably that the first cost is a minimum at the expense of a minimum working cost, as the contractor is interested only in the cost of installation; if the money thus annually wasted be capitalized, he says, it will generally be found to exceed the sum which, in the first instance, would have been expended in order to avoid the faults. He takes up a number of subjects, such as the time of lighting, the cost of power, and the capacity of the plant, showing how greater economy may often be obtained by designing the plant intelligently; he calculated roughly the cost in a number of different cases, showing how a saving can be produced by forcing the lamps for instance, or by using a larger storage battery in order to enable the gas engine to be run at better economy.

Relation of Expense to Income.—From the report of the Metropolitan Electric Supply Company of London, the sale of current in the year 1892 showed an increase of 34 per cent over that for the year 1891, while the total generating expenses increased only about 3 per cent. All items, execpt coal and repairs, have shown a decided diminution. These figures show very conclusively how slowly the generating expenses increase in proportion to the output of the station.

Central Station Accounts.—The Lond. "Electrician," April 21, gives an interesting diagram showing graphically the relative distribution and the amounts of money expended in various portions of the plant. It consists essentially of rectangles of different lengths and differently shaded portions, whose sizes are proportional to the amounts of money.

Dundee Station.—The Lond. "Elec. Rev.," April 21, gives a short description accompanied by a number of large cuts of the Dundee station, which is said to be a representative one. The three-wire continuous current system is used; 48 accumulator cells having an output of 100 amperes for 7 hours are used in conjunction with the station; the regulation of these differs from the usual method; the switches are placed near the apparatus and are worked near the main switchboard by means of gearing, which saves the use of heavy cables; the regulating cells are charged by the current which comes to the lamps; this enables the voltage of the lamps to be varied without altering that of the dynamo. Air condensers with an area of 4,500 square feet of condensing surface are used; the steam pipe is in the form of a ring which enables any section of the pipe to be cut off without interfering with the supply of steam of any engine.

WIRES AND WIRING.

Concentric Wiring.—Mr. Mavor, in the Lond. "Electrician," April 21, replies to Mr. Walker's criticism, abstracted in our issue of April 29. He denies that it is necessary for the duration of a cable that there shall be no metallic conductor outside of the insulating material; he shows how by increasing the section of the earthed conductor the electrolysis may be diminished by diminishing the loss of volts in that conductor. During an experience of over seven years he has never heard of a single instance of trouble arising from the earthing of the outer conductor in concentric wiring. He gives a formula for calculating the disturbing effect on a compass needle on board ships, by a current flowing through a single conductor; by a judicious arrangement of concentric conductors the maximum possible disturbance may be kept within one-fifth of one point while the greatest probable disturbance would not exceed one-twentieth of one point, which is within the limits to which it is possible to steer the vessel; the position of dynamos has often a much more important bearing on the compass than the wiring. Regarding the fire risk, he states that he has frequently created artificial faults of different kinds in concentric conductors, and in this way has tried to communicate fire to inflammable material, but always without success; he doubts whether the "virtually" concentric cable was truly a grounded concentric cable.

Insulation Resistance of House Circuits.—Referring to Mr. Carter's article, which was abstracted in these columns in the issue of April 22, the Lond. "Elec. Rev." states that in their opinion there is much more, as regards good insulation, in careful work than in quality of material, as the joints form such an important part; a good workman for instance can obtain a fairly good result with a low quality of wire; it agrees with the statement that the total cost of an insulation is so little affected by the extra cost between a low and high quality of wire that there is little excuse for using the former.

ELECTRO-CHEMISTRY.

Application of Electricity to Chemistry.—The Lond. "Elec. Rev." and "Electrician," April 21, reprint a lecture by Mr. Swinburne on this subject. It is written in a semi-popular style giving a short resume of the subject, and as such is interesting reading. He gives a number of the properties of electrolytically deposited substances. In speaking of the electroplating with silver he mentions the Arcas process in which a small percentage of cadmium is added, the sulphite of which is yellow and as it has a greater affinity for sulphur than silver it combines with it to form a thin coating of cadmium sulphite, which protects the silver from being blackened by sulphuretted hydrogen. In speaking of the manufacture of soda and bleaching powder he states that the solution of caustic contains a great deal of undecomposed salt, and to overcome this objection the anode in the Kellner and Vautin process is in one chamber and the cathode in the other, the two being separated by a partition of mercury forming two complete cells; in the chlorine cell the carbon is the anode, and one side of the mercury the cathode, the sodium being deposited into the mercury; in the caustic department the other side of the mercury forms the anode and the sodium is dissolved out, hydrogen forming at the cathodes; by this means the caustic is obtained pure without being mixed with salt. If the caustic is allowed to mix with the rest of the liquid chlorine is no longer given off, but the salt is changed to hypochlorite of soda which is used for bleaching; if this operation is carried on at a high temperature chlorate is formed—a method now used on a large scale for manufacturing chlorate of potassium from the chloride.

Purification of Sugar.—A short article in "L'Electricien," April 15, taken from "Genie Civil," refers to the possibilities of the application of electrolysis to the purification of sugar. It speaks of the Fahrig process, which consists in bleaching the sugar by means of ozone produced by passing electric discharges through the sugar. In recent experiments made in Hoym, Germany, the reheated juices are subjected for eight or ten minutes to electrolysis between zinc electrodes (35 to 40 amperes, 4 to 5 volts) when a thick viscous deposit will precipitate at the positive electrode, which gradually falls to the bottom and which is separated from the liquid by filtration; this deposit is one-third oxide of zinc; the juices and the sugar are absolutely free from this. Regarding the possible inversion of the sugar by the current, as has been suggested, he thinks there is no reason to fear it, judging from the experiments of Mr. Groinigg, which have been very successful.

Electrolyzing the Rare Earths.—According to a note in the Lond. "Elec. Rev.," April 21, recent researches of Dr. Kreuess show that electrolysis affords a method for working up the materials of the rare earths. A solution of an earthy chloride behaves on electrolysis like a solution of hydroxide in dilute hydrochloric acid; chlorine and hydrogen are evolved and the solution loses hydrochloric acid, allowing hydroxide to deposit in increasing quantity in proportion to the decrease of the solvent; in this way quantities of the earths can be eliminated from the chloride solutions of mixtures of the rare earths, those bases which are weakest in hydrochloric acid being first thrown down as hydroxide as soon as a part of the hydrochlorides are decomposed; the stronger bases remain in solution as chlorides; electrodes of large surfaces are found most desirable. From the results obtained with yttria it appeared that an electrolytic method of some commercial importance may soon be elaborated.

Electrolysis by Alternating Currents.—Mr. Malagoli, in the "Bulletin de l'Electricite," states that the necessary condition under which the phenomenon of electrolysis by alternating currents is possible is that the quantity of

electricity which passes during a single alternation is greater than double that which is required to produce the maximum polarization in the bath; electrolysis ceases when these two quantities are equal; the quantity of the electrolyte which is decomposed is proportional to the difference of these two quantities.

MISCELLANEOUS.

Ozone.—The Lond. "Elec. Rev.," April 21, gives an appendix to its long serial on the application of ozone, mentioned before in these columns. It states that not one of the apparatus described is of any practical or commercial use except for inhaling or spreading ozone in rooms. It describes the apparatus of Villon, Korda, and a later form of the Andreoli apparatus. Regarding the aging and refining of wines and spirits it says that the beneficial action of ozone on beer, wines and spirits is undeniable; in Burgundy, Algeria and other wine districts there are several installations where wines and spirits are ozonized; near Macon (France) within the last four or five years hundreds of casks of wines are daily treated by ozone. Regarding the purifying of water it states that ozonized air is aspirated by the vein of a descending current of water which draws in the air and carries it with the current; in this way the ozone combines more premanently with the water. Passed at the same time as chlorine through a convenient solution, ozone quickens and cheapens in a remarkable manner the manufacture of chlorate of potash. The bleaching of sugar by ozone, it states, is a fact beyond scepticism; the cost of ozone has up to the present time been the only reason which prevented its application. The application of ozone in the oxidation and bleaching of oils requires that no nitrogen be present; only ozonized oxygen can be used. The oxidation and transformation of oils take place with surprising rapidity. Camphor of the purest quality is made by the oxidation of camphene by ozonized air.

Speed Indicator.—A very cheap and simple form of speed indicator, of the tachometer or gyrometer type, is described and fully illustrated in the "Elek. Echo," March 18. It consists essentially of a vertical glass tube closed at the top, like an inverted test tube, which is nearly filled with glycerine, leaving a large air bubble at the top; when this is rotated the surface of the liquid, owing to the centrifugal force, becomes more or less depressed in the middle, the amount of depression being read on a scale contained on a stationary glass covering; the tube is necessarily vertical, and the rotation is transmitted to it by a suitable cord and pulley. Sensitiveness is obtained by diluting the liquid; the indications respond quickly and are said to be capable of being read to a great degree of accuracy, in one instrument a variation of speed of 0.4 degree being noticeable. In one form the tube is inclined by a small angle from a horizontal line, which increases its sensitiveness very greatly. Pocket instruments for temporary use and for horizontal shafts are made by gearing an apparatus like an ordinary speed counter, by means of conical gears, with the hanging, vertical glass tube.

Earth Currents in India.—The paper referred to in the issue of April 29 has since appeared in full, with cuts, in the Lond. "Electrician," April 21.

Training of Electrical Engineers.—The Lond. "Elec. Eng.," April 21, contains a third article on this subject.

Electrical Progress in Germany.

(From Our Special Correspondent.)

The central station at Bockenheim, near Frankfort-on-Main, on the Lameyer system, has been running since Jan. 1 of this year. A certain interest attaches to this station, in that the current supplied for motor work is considerably in excess of that for lighting, whereas all existing municipal stations in this country in which steam and not water power is used for driving the generators have found only a limited use of current for motor work. The Bockenheim station furnishes current for motors at about 3½ cents for the equivalent of one brake horse power on the motor. This extraordinarily low rate is due to the peculiar system of distribution adopted, which admits of the motors being run directly off the high tension drehstrom mains, while Lahmeyer multiphase dynamotors furnish continuous current for lighting at 110 volts over the whole system. The majority of the more important factories in Bockenheim have abandoned the use of steam and adopted electric energy. The central station plant consists at present of two large steam drehstrom dynamos and two continuous current machines, aggregating 540 h. p. The current is supplied to motors mostly of 15 h. p.

The administration of the Royal Saxon State Railways has decided upon the erection of a central electricity works to supply all the railway stations in Dresden with light and power. A number of different projects were submitted; Messrs. Siemens & Halske's drehstrom tender was the one accepted. The ultimate total capacity of the station will be 1,300 h. p. The installation will consist of 5 boilers, 4 steam engines, each of 330 h. p., and a similar number of drehstrom dynamos running at 100 revolutions per minute. The station voltage of 120 volts will be transformed for transmission up to 3,000 volts and reduced at the points of consumption to the proper tension. The area to be lighted will cover about four miles, and will comprise 600 arc lamps and 3,000 incandescent lamps. The work has been divided between Siemens & Halske and the Helios Company, and in such manner that the arrangement of the whole installation on the basis of their tender, as also the complete equipment of the central station, together with the supply of the motors and continuous current transformers, will fall to the former, while the laying of the cables, all the lighting fixtures and the necessary transformers will form the Helios Company's part of the contract.

It may be taken as a telling proof of the impetus given to electrical work in this country by the Frankfort exhibition that that city boasts this year no less than 110 more technical establishments and workshops than it did in 1889. Of this number 19 are electric lighting firms, 13 electrical works and 6 electro-technical undertakings; none of which existed in 1889. In the rest of the number are comprised factories for the construction of chemical and hydraulic apparatus, machine shops and stores, installation contractors and general mechanical workshops. This would seem to augur well for the electrical trade in Germany, yet, while there is no lack of work generally, and new projects are continually coming up in Germany and elsewhere in Europe, for which the German manufacturers compete largely, and, it may be said, successfully, profits are kept low by the already severe and daily growing competition in every department of electro-technics. Even in the electric tramway business, which is of course only in its infancy in Europe, competition is hard, although there are not more than three firms in Germany that can go in for such work on the basis of experience and can point to actual results attained.

Less pleasing is the contrast to the above generally encouraging picture afforded by the affairs of a local incandescent lamp factory—the Gluehlampenfabrik Patent Seel—which has just gone into liquidation. The failure is attributed primarily to the excessive competition in the incandescent lamp trade, and the competition made by the incandescent gaslight system.

Hamburg has been the scene of a protracted, and, except perhaps to those who have contributed to it, somewhat wearisome controversy regarding the electric light, recalling in some points the Frankfort electric lighting question—which, by the way, appears to be sleeping the sleep of the just, and to the resurrection of which electrical people are looking forward with much interest—although the cases are in general entirely dissimilar; in Frankfort it is a question of the erection of a complete new station, while in Hamburg the problem is the extension and leasing of an existing station. The advocates of the schemes proposed by Siemens & Halske and the Allgemeine Elektricitaets Gesellschaft as against the Schuckert system, on which the present station is built, have been laudably persistent in their efforts to make themselves heard; but after several pamphlets—one of which appeared with the quasi-classic heading, "Licht, mehr Licht"—and a fair measure of newspaper articles had been prepared for the delectation of the municipality and the good burghers on the Elbe, the question was definitely settled in favor of Schuckert & Co. The case was of a somewhat complex nature, and it would be impossible to give an intelligible and succinct account of the same without referring at considerable length to the earlier history of the electric light in Hamburg.

At the January meeting of the Hanover Electrical Society Dr. F. Meissner, of Gottingen, read a paper on one of the latest transmission of power plants in Europe, viz., that at Furstenfeld-Bruck, designed and carried out by Herr Oscar von Miller. After giving a brief exposition of the reasons that led to the adoption of the single-phase alternating current, and the system of distribution in general, Dr. Meissner proceeded to describe the installation in detail with the help of a number of very instructive drawings, lent for the purpose by Herr von Miller.

Furstenfeld-Bruck is a little town near Munich of some 3,000 inhabitants. The parish numbers among its possessions a water mill, distant about 4 miles, with an available capacity of 200 h. p. Of this 120 h. p. is utilized at present, the power being transmitted to the point of distribution by ordinary alternating current at a pressure of 2,500 volts. The primary station, which is fully equipped with all the necessary apparatus, comprises at present two Knop turbines fitted with brake regulator, driving on a common shaft two alternating current generators built by Brown, Boveri & Co., of Baden, Switzerland. The current developed by these machines, the excitation of which is effected by a separate continuous current dynamo, is conveyed over an aerial line, composed of six millimetre diameter (between No. 2 and No. 3 B. & S. gauge) copper wire, to the outskirts of Bruck, whence it distributes itself over the branches of the primary circuits covering the area of supply, and to which further on 10 transformer stations are connected. The latter, containing transformers by the same firm, feed in turn a low-pressure (100 volts) distribution network, from which the house installations take their current. The whole of the lines are overhead, and while this has introduced no appreciable disfigurement anywhere, it has very materially reduced the cost of installation. A line between the secondary network and the primary station provided with measuring and telephone apparatus, and running on the same poles as the high-tension circuit without being in any way influenced thereby, enables the voltage to be regulated, and affords at the same time a means of communication in case of necessity. Particular interest attaches to the motors—also by Brown, Boveri & Co., and of which a good many have been installed already—in view of their perfect operation; they have replaced in many instances the primitive methods of hand power, which are not yet entirely obsolete in some of the smaller industries. The current is employed further in electric ironing, heating and cooking apparatus. At present there are installed some 1,230 incandescent lamps and eight arc lamps, together with 10 motors, aggregating 15 h. p. The rate for current supplied is $5 a year, irrespective of the time or purpose to which it is put.

If it is not actually taking time by the forelock, a very close approximation to that idea is that which the Berliner Elektricitaetswerke have just brought to the notice of the public in an invention of Herr F. von Hefner-Alteneck, by which clocks may be electrically regulated and run direct from the central station, and at trifling cost. The Elektricitaetswerke have made an arrangement with this object with the Obsrevatory, and invite current consumers to test the success of the idea. The clocks have a simplified wheel mechanism with pendulum and electric winding device. An interruption in the current supply will not affect the working of the clocks, so long as such interruption does not exceed, say, 12 hours. The winding arrangement referred to contains an electromagnet, working with a so-called automatic circuit breaker; care has been taken, however, to prevent any injurious sparking. All the clocks installed will be timed at the same hour once every day, so that it will be impossible for any appreciable time difference to exist. This regulation will be effected from the central station by means of a slight momentary reduction in the potential over the whole system. A time will be selected when only very little light is required, and when an even voltage is on the circuits and a momentary drop in the same will not be noticeable in the few lamps burning. It has been found that 5 o'clock a. m. will be about the best time for this purpose.

Electricity in the Times of Columbus.

BY PHIALUS VACUUS.

The arrival in the port of New York of the caravels in which the bold Columbus had the temerity to embark so that he might discover us afforded an excellent opportunity to anxious searchers after electrical knowledge to investigate the great and momentous question, "Electrical Development in the Time of Columbus." Argument has been offered to show that neither Columbus nor any of his captains would have known a volt from an ampere had they chanced to meet either of them on America's coral strand; and, although his arrival was a considerable shock, the doubting Thomases affirmed that it had no electrical origin, although the result was certainly disastrous to the natives.

No sooner were the ships moored to the massive white marble wharfs, than the deputation from the Society of American Electrical Engineers invaded their sacred precincts. The deputation was divided into the "stoppers," the "gassers" and the "vacuers" and "feeders," and each clique considered itself the only reliable, truthful and wise, and the others rogues, knaves and infringers.

As the party started down the drawbridge of inlaid mahogany the acrimonious discussion continued.

They first investigated the high poop which reared its lofty deck level with the beautiful wharf. Traces of wires were found, to which the "gassers" and "stoppers" triumphantly pointed as proving their asseverations. This view was instantly rejected by the "feeders" and "vacuers," who hinted that the wires must have been used by Juan Perez in connection with Isabella and Ferdinand. A little more poring brought to light what the "feeders" said looked like a junction box. This was shown to be incorrect by the "gassers," for the marks upon it proved it to be Columbus' official mouse trap—and that, although their opponents might make a junction box out of it, the mouse never could.

Then the "gassers" found some holes, which they averred were holes for deck tubes. Much discussion again arose, and the "feeders" proposed that permission be asked to take the holes to the next session of the society for careful exmination. This idea was scouted after it was discovered that they were the lee scuppers. The next exciting news was that the "main circuit" had been found, but this proved on investigation to be incorrect; the electricians had stumbled on the main brace neatly spliced. A switch was found, but did not help matters, for it was found to have its origin in Columbus' wig.

The investigating party had now gotten into the hold. They had not yet found anything, and some of the more ribald and incredulous began to hint that there was no electricity in Columbus' times, and that the Christian hordes had been too busy cutting the throats of the noble Abencerrages to make any, when suddenly a venerable member, a spectacled graybeard, uttered a cry. A rush was made to the place. Protruding from behind one of the ancient ribs of the ancient vessel, showed a little

bright point, which, drawn from its position, proved to be a small glass phial. This was conjectured to be Columbus's scent bottle, but the idea was derided, for, "How did he get it out?" Some said it held the hairpins which Isabella had sent to America's daughters as hints to tidiness. Others that it contained a model of an Aztec violin bow which Columbus had found and preserved. The little bottle was crude in form, and indented at one end. Hippo junior viewed it with suspicion as something which had recently been concealed on the vessel. The discussion waxed hot, the "vacuers" and the "feeders," upheld by Pisces, looking upon the little bottle as an invention from lower than the lower hold, and the "gassers" and "stoppers" taking to the bottle seriously, as tho' they loved it. "It was no fraud," they said; "electricity did exist in Columbus' time," and the discussion waxed furious, for a Westerner, Dammit, by name, had sided with them as against Hippo junior, considering himself quite as good a judge as he.

Then from the deep vault of heavenly azure were heard the resonant tones of the divinely inspired—the mighty anticipator: "It is a Goebel lamp! ! !" and away in the distant errigkeit the Elysian choirs were heard sweetly chanting that heavenly creation—"Ta-ra-ra-boom-de-ay."

The Electrical Illumination of Steam Railroad Cars.

On April 21 the first public trial of the new Young-Moskowitz system for lighting railway cars with electricity was made. Car No. 220 of the Central Railroad of New Jersey, which had been fitted up for the experiment, was comfortably filled with well known electrical and mechanical engineers and business men, and at 8:40 left the Broad street station attached to the Roselle accommodation train. This branch road is considered to be one of the worst in the country, and, therefore, the test was a particularly severe one. The second and third trial trips were made later for and by the request of the officials of the Central Railroad of New Jersey, a number of the most prominent of whom were present, and expressed themselves as very well satisfied.

The system originated with Mr. Samuel Young and Mr. A. Moskowitz, of Newark, and has been carefully worked up by them. It is financially supported by Leon D. Adler and Joseph Leowenberg. It has long been the aim of those interested in this line to devise a practical system of car illumination, in which the car axles should be the source of power, but various difficulties have been experienced, chief among which is that of securing a constant speed for the dynamo regardless of the rate of rotation of the car axle. It is claimed that in this system these difficulties have been entirely overcome, and that the dynamo revolves at such a uniform speed that the lamps fed by it burn at the same candle power whether the train is moving at 7 or 70 miles per hour. The fact that bogie trucks are used, and also that the train goes both forward and backward, adds greatly to the trouble of obtaining satisfactory results.

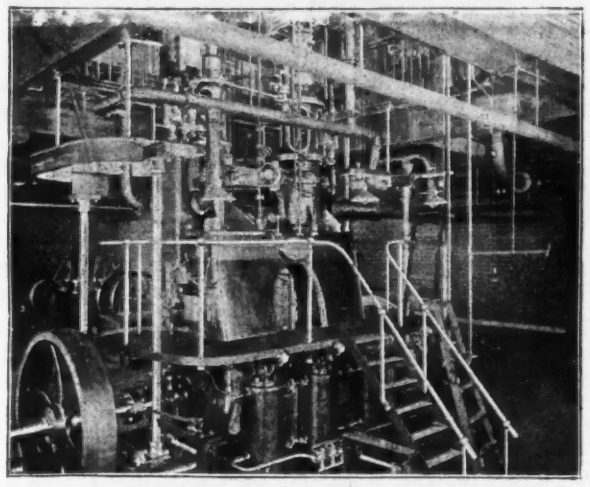
Upon the truck axle, which acts as main shaft of this system, is placed a sprocket wheel, and a sprocket chain runs from this to a countershaft which is suspended in brackets from the bottom of the car. This countershaft is connected by another chain to a third shaft, which is fastened to the bottom of the car, and by means of a belt runs the dynamo, which is placed in one corner of the car. In order not to throw an additional load upon the engine when the train is starting up and all the power is needed, an automatic device has been provided by which the system does not begin to operate until the train has acquired a speed of seven miles per hour. The question of maintaining a uniform speed in the dynamo was solved by the use of Evans' friction cones, so arranged that one runs the other and the speed is regulated by means of a belt which is moved forward or backward by a centrifugal governor attached to the lower cone and regulated by the speed of the car. This feature, which is a most vital one, is claimed to have given excellent satisfaction.

In connection with the dynamo is also a system of storage batteries, so arranged that when the speed of the train falls below seven miles per hour the dynamo is cut out of the lighting circuit and the storage batteries switched in. These batteries are fed either by the excess of current generated by the dynamo when the train is running at a high speed, or when the dynamo current is not needed for the illumination of the cars. The system is simple and practically automatic, so that it requires a minimum of attention, and is claimed not to be liable to accident or injury. The entire system, including the batteries, weighs about 1,000 pounds. This, however, is the first model built, and, while it serves to prove the practicability of the system, the inventors claim that the weight can be reduced and the apparatus otherwise improved.

The car is brilliantly illuminated by 25 8-c. p. lamps, and has traveled during the last few months between Newark and Roselle nearly 4,000 miles over all sorts of crossings and curves, and yet the apparatus is stated to be in perfect running order. The inventors are sanguine of the success of the system, and a satisfactory method of lighting cars by electricity would be welcomed both by railroad officials and the long-suffering public.

Engineering at McGill University.

The new Engineering and Experimental Physics Buildings of McGill University were recently formally opened with appropriate ceremonies. Addresses were delivered by the Governor-General of Canada, the Chancellor of the University, the President of the American Institute of Mining Engineers, Sir Casimir Gwoski, Dean Bovey and others. The keys were presented to Sir Donald Smith, the Chancellor, by W. C. McDonald, Esq., the donor of both buildings, and were encased in a box made from the wood of the steamer Beaver, the first steamer to round Cape Horn. In the afternoon a conversazione was held in the Physics Building, where the professors and friends met, and speeches were delivered by Prof. Cox, M. A., the new experimental physics professor,



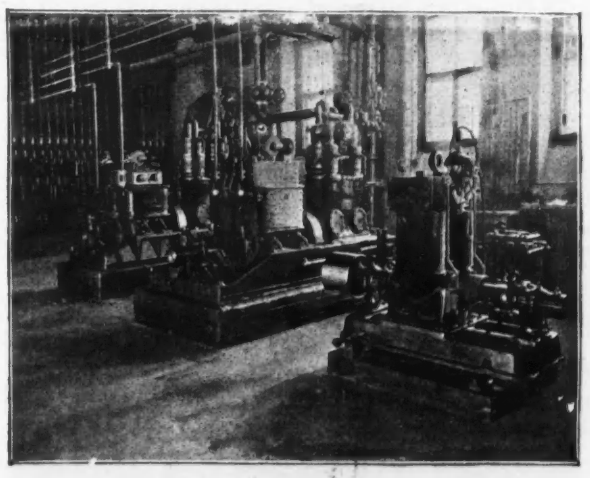
90-H. P. QUADRUPLE EXPANSION ENGINE.

and also by Prof. Barker, of the University of Pennsylvania, and Prof. Eggleston, of Columbia College. Prof. Barker declared the buildings and equipment to be the finest in America. A brief description of the Engineering Building may prove of interest.

In entering the main part of this building, to the right is seen the electric laboratory, where all the testing instruments and supplies are kept. The collection comprises about 20 Weston voltmeters and ammeters, four ballistic and one Thomson galvanometer, a Siemens and a Thomson dynamometer, a Thomson static voltmeter and two of his very fine electric balances, several post-office boxes of different sizes, two Cardew voltmeters, standard cells, standard resistances, an Evershed ohmmeter, two Westinghouse and one Aron meter, about twelve English voltmeters and ammeters, and a large collection of switches, fuses and many other instruments. All the delicate work is done upon slate slabs set into the wall, so that no motion of the floor has any effect on the instruments. On the right is the cement testing laboratory and electrical workshop, where a lathe is set for fine brasswork, run by a Crocker-Wheeler motor. Off this is an excellent photometer room.

On the ground floor to the left is the dynamo room, where all the dynamos and engines for lighting and experimental work are placed. A Siemens dynamo of 300 amperes and an Edison-Hopkinson machine of the same capacity are both directly connected to two double compound engines of 60 h. p. These two dynamos can be run on the three wire system, or one alone on the two wire system, and are used for lighting both buildings with about 1,200 incandescent lights.

A 5-h. p. Crocker-Wheeler motor is connected to a similar machine which generates the current for charging the storage batteries, of which there are about one hundred. One 500-light and two 250-light Edison



A VIEW IN THE DYNAMO ROOM.

dynamos, one 300-light Thomson-Houston incandescent machine for driving the electric elevator, one arc dynamo made by the Royal Electric Company, of Montreal, a Wood arc machine, two of the London Brush and one of the American Brush type, and a collection of motors of different makes complete the electrical equipment. All these machines are driven by a 90-h. p. McIntosh & Seymour engine connected to a shaft which runs through the room to which the dynamos are connected by electric clutches which have been found to work very satisfactorily. The switchboard is so arranged as to indicate the volts and amperes of any circuit in the two buildings with the aid of two Weston voltmeters, one of which is used as an ammeter by means of pressure wires.

Adjoining this is the thermo-laboratory, where the large 90-h. p. experimental engine is placed. This engine, shown in Fig. 2, is quadruple expansion, condensing or non-condensing, and was made by Yates & Thom, of Blackburn, G. B.

On the left is the Atkinson gas engine, a Woodbury-Merrill heat engine, and a 50-h. p. automatic cut-off engine, made by Robb & Co., Amherst, N. S.

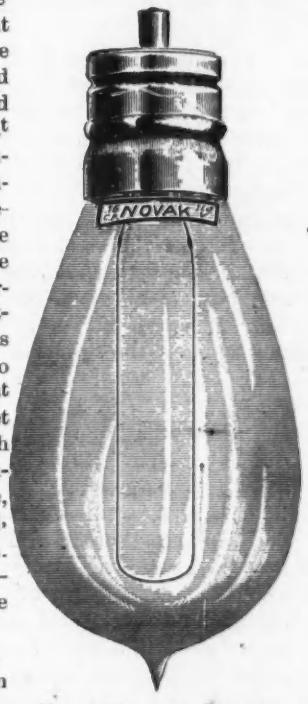
At the other end of the ground floor is the testing and hydraulic laboratory, where a large Buckton testing machine which tests up to 100 tons may be seen. The Emery testing machine is also there for tension and compression tests, and on which a test can be made from a fraction of a pound up to 75 tons, the pressure being supplied by force pumps below.

On the third floor are lecture rooms, the library, etc., while the fourth floor is devoted to drawing and designing. On the fifth floor is the museum, where the famous Reuleaux collection of mechanical models is placed.

The "Novák" Lamp.

From several points of view the period during which the incandescent lamp industry suffered from the blight of a depressing monopoly will doubtless be regarded as one of the most important in its history. The great stimulus given to inventors has resulted in keen researches in directions that otherwise, perhaps, would have never been followed, and the consequent developments are beginning to appear.

One of the controverted points in the history of the art has been in regard to the use of an inert gas within the bulb. The earlier workers in the field experimented somewhat in this direction, but the ease with which a vacuum could be obtained necessarily caused their efforts to be somewhat perfunctory; the matter consequently remained in an undeveloped state until the necessity of a substitute for the vacuum lamp caused it to be taken up again with a thoroughness never before attempted. Within a few days we have had an opportunity to examine a new gas lamp just being placed on the market by Claflin & Kimball, which promises to successfully compete with the ordinary type, and indeed has, it is claimed, a property that places it immeasurably ahead of its rival—that of retaining its full candle power during its life.



THE "NOVAK" LAMP.

The "Novak" lamp doe not differ in construction from the ordinary vacuum lamp, its peculiarity consisting in using an inert gas at atmospheric pressure in the bulb instead of a vacuum. The well and favorably known Perkins filament is used; this is manufactured, as formerly, by a secret process by Mr. Perkins, and supplied to the Waring Electric Company, 116 Bedford street, Boston, Mass., the manufacturers of the new lamp.

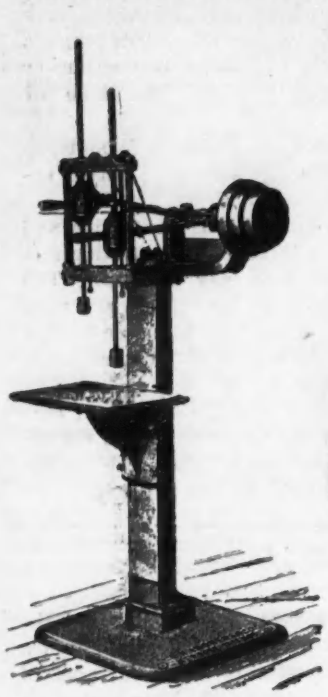
As the patent is pending relating to the gas used in the bulb of the lamp, we cannot at present give any information concerning it, but can testify that with the gas used there is no undue heating of the bulb, which disposes of the principal objection heretofore urged against gas lamps. When compared with an ordinary vacuum lamp having a filament heated to apparently the same incandescence, the temperature of the gas bulb after some minutes was little if any higher, and a lamp that had been lighted, we were informed, for four days continuously did not have a higher temperature.

The most notable claim for the lamp, however, is that it maintains its full candle power without increase of voltage or current during its entire life. If experience sustains this claim, the improvement will be the most important since the invention of the incandescent lamp, and will more than compensate for the recent complications that have led to this result being attained. The recent paper read before the American Institute of Electrical Engineers on the effect of the great increase of power required by the ordinary lamp to maintain its initial candle power showed that after a few hundred hours it would be economical to replace such a lamp by a new one, which gives an indication of the great value of a lamp that will light from 600 to 1,200 hours at its initial efficiency.

The manufacturers also state that the lengthy and thorough tests to which the lamp has been subjected have demonstrated that its average life and efficiency are fully equal to those of any incandescent lamp that has ever been on the market.

The Voss Incandescent Lamp.

We have recently described in our reading pages and patent record a number of lamps constructed on other than the all-glass receiver principle, and several other inventors are known to be working on the same line.



Vertical Tapping Machine.

The Voss Incandescent Lamp.

We illustrate a lamp constructed on the principle referred to by Mr. D. C. Voss, Niles Building, Boston, Mass., a pioneer in this line of work, who has also invented a filament that, it is claimed, possesses a much higher efficiency with the same life than those at present in use.

In the construction of the lamp the same glass globe is used as in the ordinary forms. The filament with its stem is placed inside and then the lower end closed in with the exception of a rectangular hole of sufficient size to let a small portion of the stem project, the glass bulging outward, however, at this stage, instead of being in the form of a re-entering cone as shown in the cut. The end of the stem is now pulled a short distance through the opening left, and held by tweezers; the glass and cement are then softened, and the edges of the former worked slightly into the cement, thus sealing in the stem. After softening the glass at the turn of the base the latter is pushed into the receiver so as to form a re-entering cone, as shown, when the lamp is ready to be exhausted by the usual means.

It is seen that the mechanical process of constructing a lamp on this principle is as simple, or perhaps more so, than with the ordinary forms of lamps, from which it does not greatly differ. The vital principle, of course, lies in the cement used, whose composition cannot be known until the issue of a patent now pending. It is claimed, however, that the cement, which forms the entire stem, is a perfect non-conductor, contains no silicates, has a coefficient of expansion the same as that of glass, and a melting point somewhat, but not much, lower.

A number of these lamps have been in use for some time, and it is claimed that with the non-silicious seal the vacuum is maintained as perfectly as in an all glass receiver.

Mr. Voss has also invented a filament, which is constructed by impregnating a thread with iodide of aluminium; when the filament is ready for use it is said to contain not more than 25 per cent. of carbon. We are informed that experiments with this filament have demonstrated that it can be carried to a much higher degree of incandescence than a carbon filament, and yet maintain a long life. As a result of this higher incandescence it is said that an increased efficiency of 60 per cent. is obtainable.

Vertical Automatic Tapping Machine.

The vertical automatic tapping machine we illustrate is particularly applicable for use in electrical works, and a number have been installed at the Lynn and Schenectady works of the General Electric Company, as well as with other electrical companies, by the manufacturer, E. N. Andrews, 286-290 Graham street, Brooklyn, N. Y.

The machine illustrated has two spindles for tapping holes up to ⅝ inch in diameter. The twelve gears for transmitting the motion to the spindles are made from steel forgings, and accurately finished. They are so proportioned that the backward or withdrawing motion of the taps is one-third faster than the forward or cutting motion, and taps having 1-16 inch difference in their diameters will each have its correct circular speed. The spindles have a vertical movement of 5 inches for adjusting the taps to the depth wanted from the table, and the spindles can be moved through the clutch 18 inches. There are suitable openings in the sides of the clutch and gear case for using a screwdriver. For closer adjustments two set screws are provided, one back of each spindle, for the bottom of the clutch and gear case to strike on in order to unlock the clutch when the tap has reached the desired depth.

The centre distances of the spindles are 6 inches and 7½ inches from face of column. The table is 14 inches by 20 inches, with a continuous oil groove around the edge, and can be adjusted on the column 31 inches.

This class of machine can be made with most any number of spindles to run at the same speed, or all at different speeds, to suit the requirements of different manufacturers. A suitable countershaft is furnished with each machine, having self-oiling hangers.

The Equitable Printing Telegraph.

A simple and reliable form of printing telegraph has been recently placed upon the market by the Equitable Manufacturing and Electric Company, 44 Broadway, New York City, that promises to enter largely into daily life on account of its simplicity and not requiring skilled operators, while at the same time it is none the less adapted for general telegraphic work.

The instrument consists practically of a typewriter with an electrical attachment, by means of which the message written on the tape at the sending end of the line is duplicated on a similar tape at the receiving end. The apparatus consists of a step-by-step instrument in connection with a printing wheel somewhat similar to the Gold and Stock printing telegraph. The instrument at each end of the line is always kept in unison and when a key is pressed at one end the corresponding letter is simultaneously printed at each end of the line on a tape. The important feature of the machine is the perfect manner in which, it is claimed, unison between the two apparatus is maintained; even should the unison be disturbed, which is improbable, it is again re-established before the next letter is printed.

The transmitting and receiving instrument are identical

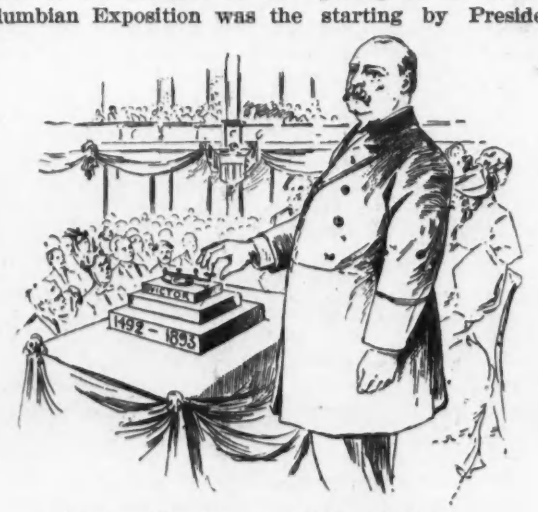
Equitable Printing Telegraph.

in all respects, and their manipulation is the same as that of the ordinary typewriter, no more knowledge being required for their successful use. The tape in front of the operator at all times gives an exact duplicate of the copy which is being recorded at the receiving instrument, and the instruments are so arranged that it is impossible to transmit a message unless it is being properly received at the other end. The only point to be observed in its use is that a key shall not be pressed until the last letter has been printed, but as its rapidity is very great this does not introduce any greater practical difficulty than the corresponding one with the ordinary typewriter.

A number of these instruments are in use in the Exposition buildings at Chicago, and although just on the market have already, we are informed, met with a great demand.

Opening of the World's Fair.

One of the features of the opening of the World's Columbian Exposition was the starting by President



Victor Key Opening World's Fair.

Cleveland of the immense machinery by simply pressing on the button of a telegraph key. As the President was concluding the final sentence of his address, "As by a touch the machinery that gives life to this vast Exposition is set in motion, so at the same instant let our hopes and aspirations awaken forces which in all time to come shall influence the welfare, dignity and freedom of mankind," his eyes wandered to the table that was close at his left hand. Upon this was the key the pressure upon which was to start the machinery, and make the opening of the Exposition an accomplished fact. It was an ordinary form of the well known "Victor" telegraph key, such as is in use in most telegraph offices, except that it was of gold instead of steel, and had a button of ivory instead of rubber. As the last words fell from the President's lips he pressed his finger upon the key and the fair was opened.

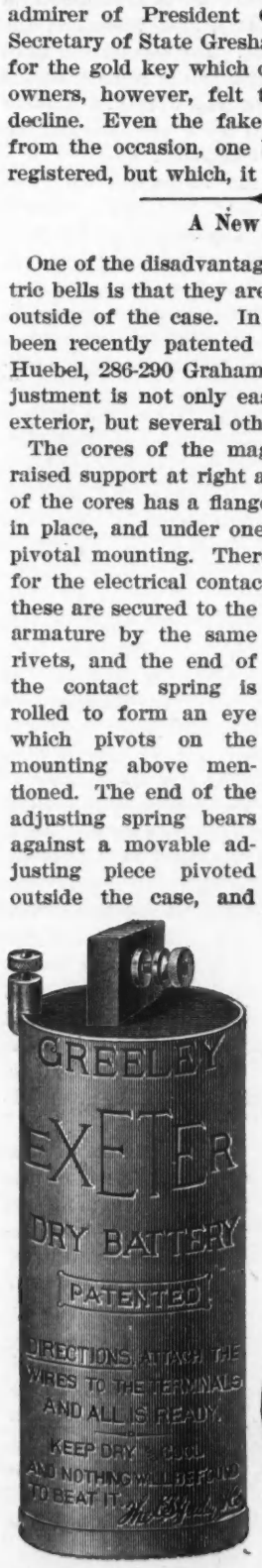
Through the courtesy of the E. S. Greeley & Co., of 7 Dey street, New York, we are enabled to illustrate the key used, which was furnished by them, as well as the dry battery (four of which were used) from which came the power that set in motion machinery of thousands of horse power.

No sooner had the Victor telegraph key performed its work and the departure of President Cleveland taken place than the stand that the key occupied was assailed by the multitude in the desire of the individuals to personally touch this now historic device, all sorts of sums, ranging from 25 cents to $5, being offered to the attendant, a representative of The E. S. Greeley & Co., for the privilege of simply touching the golden Victor key, and it was only by sharp and somewhat summary action on the part of attendant that the key itself was saved from the mob and hurried off to the safe deposit vaults for security. Even the line wire which connected the Victor key with the operating machinery was eagerly sought for, the Greeley company having presented the line wire to the lineman who ran the line, who subsequently made a large profit out of it by cutting into small pieces and selling the same to the crowd as souvenirs. Without freedom to disclose the name of the principal it is also a record of fact that an enthusiastic admirer of President Cleveland, a personal friend of Secretary of State Gresham, made an actual bid of $5,000 for the gold key which opened the Fair, which offer the owners, however, felt themselves under obligations to decline. Even the fake museum fiend was not absent from the occasion, one bid of $3,000 for the key being registered, but which, it is needless to say, was rejected.

A New Electric Bell.

One of the disadvantages of the ordinary forms of electric bells is that they are not readily adjustable from the outside of the case. In a bell we illustrate, which has been recently patented by F. W. Manger and O. H. Huebel, 286-290 Graham street, Brooklyn, N. Y., the adjustment is not only easily and exactly made from the exterior, but several other good features are introduced.

The cores of the magnets are riveted to the usual raised support at right angles to the base; the polar end of the cores has a flange which holds the magnet spools in place, and under one of these flanges is secured the pivotal mounting. There are two springs, as usual, one for the electrical contact and the other for adjustment; these are secured to the armature by the same rivets, and the end of the contact spring is rolled to form an eye which pivots on the mounting above mentioned. The end of the adjusting spring bears against a movable adjusting piece pivoted outside the case, and which is movable without loosening a screw, thus enabling adjustment to be easily made.


GREELEY
EXETER
DRY BATTERY
PATENTED
DIRECTIONS. ATTACH THE WIRES TO THE TERMINALS AND ALL IS READY.
KEEP DRY COOL AND NOTHING WILL BE FOUND TO BEAT IT.

Exeter Dry Battery.

New Electic Bell.

Another improvement is a square washer in a rectangular depression under the binding post, which enables the terminal wires to be secured without danger of being twisted off, as is too often the case when circular washers are used.

Fixture Cut-Outs.

BY E. D. WEBER.

Referring to your editorial note in The Electrical World of the 6th instant on fixture cut-outs, I had supposed fixture cut-outs a thing of the past, and understood that wiring of the kind was no more. The practice that I have followed is to put a small number of lights on each circuit and solder all fixture connections solid. In residence lighting, where there are a large number of lights on one fixture, two or more circuits are run to the fixture so that there may not be over six to eight lights on a circuit. With single light brackets, from four to six brackets are put on one circuit. This seems preferable to a fixture cut-out, with fuse wires, as on neat fixtures when the fuses have blown a few times, as sometimes occurs, the fixture canopies and walls soon become soiled by handling, especially where the papering or frescoing on walls is of a delicate color. By using Nos. 14 and 16 wire on fixtures and making solid connections, there is only one junction fuse block to look after. Still another reason why fixture cut-outs should be done away with is that in time many insulating joints become defective, and gas leaks at the joints develop; when gas escapes and the fixture is properly put up, with the canopy shoved close to the ceiling, it makes a reservoir for the escaping gas, and should a short circuit occur and blow the fuse at such a fixture the gas becomes ignited, and a large scorched and blackened spot on a ceiling is the result. I have seen ceilings around combination fixtures very much disfigured by such occurrences, and I think all persons, especially electricians, should get the best possible and safest plans for electric light wiring, especially where combination fixtures are to be used.

I think fixture cut-outs, or "bugs," are an injury instead of a benefit to the electric lighting business, and far more safety and much less trouble will be found when there are a small number of lights on a circuit and only the junction blocks to look after, than where fixture cut-outs, or "bugs," are used under canopies.

The Relations Between the Electrical and Insurance Interests.

Mr. James A. Waterworth, president of the St. Louis Board of Fire Underwriters, recently read an unusually interesting and clever paper on the relations between electrical and insurance interests before the Electric Club of St. Louis.

The ground taken by Mr. Waterworth was, that while in business as in human relations the first law is that of self-preservation, it should be remembered that there are other laws equal to and concurrent with this, which must be none the less taken into consideration; the permanent prosperity in both relations also vitally depends upon observing what may be called the laws of comity, of association, of the capacity to live and thrive together. These principles apply to the two interests in question; there is a common ground on which they are compelled to meet and act, a point at which there is a common interest, and at which they can mutually serve or injure each other; accordingly as they occupy this ground intelligently and peaceably, in like proportion will they occupy it successfully.

Mr. Waterworth asserts, what cannot be easily controverted, that it is the lot of fire insurance to pay for all improvements and experiments. Until refined petroleum had developed a burning fluid of reasonable safety, when flouring mills were changing to the roller process, when sugar refiners got ready to change their methods, and so with every invention while it is being introduced by tyros and installed by unskilled labor, the fire insurance companies pay for the experimenting. If they hesitate they are helped to a decision by a jury of their countrymen.

At its first introduction electricity did not make a favorable impression. It was reported by its best friends to be erratic, whimsical, and even dangerous. It brought with it a motley multitude of hangers on and a foreign nomenclature. A new class of men, known as experts; sprang like an exhalation out of all sorts of occupations; they knew nothing about electricity, but soon learned to patter about volts and amperes and short-circuits, and to paralyze the boldest citizen with these and such like cabalistic expressions. In 1888 it took about three weeks to convert a mechanic into an electrical expert, and while these men were contracting and doing work, you may readily suppose that they did not commend electricity to insurance companies as a harmless innovation.

As to the insurance agent, he himself is rarely more than ten years in advance of the community in scientific matters, and it must be confessed did not know a bit more about electricity than the electrical experts referred to. He was not so much scared by electricity as he was by the expert talent; the insurance companies were scared, however. Whatever else they might or might not know about electricity, they knew they had to pay for it. They were right, and as they paid at once for the first central station in St. Louis, and then they were sure that electricity was an incendiary of the first order.

This was the situation in the beginning, and the insurance companies could not be blamed in keeping the law and practice of self-preservation well to the front. Nevertheless, with every temptation to do so, the St. Louis Board of Fire Underwriters did not set themselves up as dictators to the electrical interests, or take any advantage of the situation. The first set of rules governing electrical installations was presented and recommended by St. Louis electricians, and they were adopted for the mutual benefit of both interests. What has been attained since in perfection and safety of installation, in intelligence and competency of inspection, has been grown up to; we have educated ourselves and advanced with equal step.

Mr. Waterworth considers the question of inspection and concludes that it should rest, as at present, with the insurance companies as having most at stake.

The survival of the best and strongest elements in the electrical business, the dying out of the mushroom expert, and other desirable objects are attributable to the high standard adopted for electrical work, and the harmonious relations which have secured its application.

Mr. Waterworth states that in practice it has been decided in St. Louis that electricity is not a fire hazard when installed with all the safeguards science can suggest, and as a consequence it is admitted as an illuminator and as a power without charge for it as such. Personally he believes that in all its uses when properly installed, it is an improvement over that which it has displaced.

Electric Launches for China.

The United States Consul, Mr. John Fowler, at Ningpo, China, in a recent report to the State Department calls attention to the immense field for launches and other power boats on the great canals of China. He gives the following as suitable dimensions: Length, 38 feet; breadth 6 feet, 10 inches; height from keel to rail, 3 feet; height from rail to top of house, 2 feet 9 inches.

Mr. Fowler has been requested by the Taotai or Governor of the Ningpo district to obtain for him information relating to such launches, and thinks that the present is a very opportune moment for Americans to introduce them into China.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, May 8, 1893.

NEW YORK GENERAL FINANCIAL STOCK MARKET.

Utter demoralization, on the verge of a panic, has been the fate of the stock market during the past week, and as industrials were severely pounded electrical stocks have suffered tremendously. In fact the greatest jumps and breaks in the market, with one or two exceptions, were from electrical quarters, General Electric in the van, but in such turbulent times it is a staunch ship that can withstand the storm. For the past two or three weeks the dealing in electrical securities has been marked only by extreme dullness, with scarcely any trading and an unsettled and shaky feeling, which was generally ascribed to the stringency in the money market, but with electrical holdings has other causes.

General Electric.—The first change of any note which occurred after several weeks of inactivity was in General Electric the day following the decision in St. Louis, disallowing a temporary injunction to the trust. This decision, which was so satisfactory to all the outside rivals and hailed as a great event in St. Louis, had an immediate effect upon General Electric stock, which previous to the announcement had been selling a little above par, and upon the news of the decision dropped several points below par, and only recovered its lost position after several days manipulation by the bull clique. For the General Electric Company to keep its quotations above par it must surely hold on to all its patent rights and monopolies, and any legal act which threatens them is soon felt in its securities. The decision in St. Louis not granting an injunction to the General Electric people makes the incandescent lamp question more unsettled than ever, and then there is the incandescent lamp which is claimed not to infringe the Edison patents, and a lamp that is made of many parts may only conflict with a fractional part of the General Electric Company's claims. All of these matters have an intrinsic value bearing upon General Electric stock, and may count in the future. The present drop in the trust's stock came like an avalanche and undoubtedly surprised the inside officials of the company more than any one else, as reports are many of large purchases made by the officials of the stock when it was par and a little below. On May 1 General Electric closed at 98⅜, and from that time gradually fell off each succeeding day, sometimes falling two or three points at a jump until finally it reached bottom May 5, when 800 shares were sold for 58. From that point it turned gradually, working upward, the closing sale Saturday being 200 for 81½. The debenture 5's were likewise affected by the times, going as low as 85, but recovering to 94 at the end of the week. On Monday, May 8, General Electric fell to 74 and closed at 79.

The Edison Electric Illuminating of New York, of all the listed electrical securities stood fire the best during the great slump. This stock, quoted at 120 May 3, which was below its usual standing, closed only four points below this May 6, its lowest quotation being reached on Friday, when it went down to 110.

Western Union, old and staid as the security is, felt the crash like the rest and dropped as low as 83, but rallied to 85½ at the closing Saturday.

All other listed securities feel off a few points, though very few sales were made in any of them.

In the unlisted electrical stocks there has been scarcely any trading for weeks past and they are all quoted at old ratings, which may seem high under the present financial conditions, yet their intrinsic value warrants it.

With the exception of the General Electric all the electrical securities withstood the bear shock remarkably well, making a much better comparison than the other industrials. The present week promises to be an exciting one, as a general uneasiness prevails until the Clearing House statement is out, showing the standing of various firms. It is known that several houses are financially involved which are heavy holders and manipulators of electrical stocks, especially General Electric, thus making it probable that a great deal of this security may be thrown upon the market, with the consequence of low figures. With the unstable financial situation and downward tendencies of the market the prospect is not bright for electrical securities to appreciate to any extent in the immediate future.

ELECTRICAL STOCKS.

Brush Ill., New York	50	25	30
East River Electric Light	100	..	65
Electric Con. & Supply Co. pref.	15	15	16
" " " " " com	15	15	17½
Edison Electric Ill., New York	100	116	116½
" " " Ists	...	115¼	116
*Edison Electric Ill., Brooklyn	100	105	108
" " " Boston	100	140	160
" " " Chicago	100	220	230
" " " Philadelphia	100	135	145
Edison Electric Light of Europe	--	2	6
" Bonds	..	80	85
" Ore Milling	..	5	12
Fort Wayne Electric	..	121½	123½
General Electric Company	100	81¼	81¾
" " deb. 5s	..	94	94½
Interior Conduit and Ins. Co	100	63	67
Mount Morris Electric	..	..	65
Westinghouse Consolidated	50	36	37
" " pfd	50	48	49

*Ex. Div.

NEW INCORPORATIONS.

The Springfield Consolidated Railway Company, Springfield, Ill., capital stock $750,000, has been formed to operate electric railways, etc. C. K. Minary, Bluford Wilson and F. H. Jones are the promoters.

The General Construction Company of Illinois, Chicago, Ill., capital stock $300,000, has been formed to construct railways, light and power plants, etc. E. S. Elliott, G. W. Dixon and B. A. Levett are the promoters.

The McKeesport & Braddock Passenger Railway Company, McKeesport, Pa., capital stock $50,000, has been formed to construct an electric railway. J. McCune, J. D. McCune and A. N. Hunter are the promoters.

The Crouch Electric Supply Company, Portland, Ore., capital stock $100,000, has been formed to manufacture and sell electric machinery, etc. The organizers are S. L. Lovell, Portland; H. J. Singleton and E. C. Giltner, Salem, Ore.

The East Reading Electric Railway Company, Reading, Pa., capital stock $100,000, has been formed to construct and operate an electric railway in Reading, Pa. A. J. Brumbach, J. H. Printy and G. W. Bard are the organizers.

The Brott Electric Rapid Transit Bicycle Railway Company, Alexandria, Va., capital stock $300,000, has been organized to operate bicycle railways. G. F. Brott, C. H. David, C. A. McEwen and E. S. Parker are the promoters.

The South Waukegan Electric Railway Company, Shields, Ill., capital stock $100,000, has been incorporated to construct and operate electric street railways. F. W. Ganse, Calvin Dickey and Bryan Y. Craig are the incorporators.

The Las Vegas Light and Fuel Company, E. Las Vegas, N. Mex., capital stock $100,000, has been formed to generate and sell electricity. The incorporators are E. D. Bullard, F. Springer, C. C. Gise, Wm. J. Mills and J. M. Cunningham.

The De Pere Electric Light and Power Company, De Pere, Wis., capital stock $20,000, has been incorporated to operate an electric light and power plant. J. P. Dousman, Wm. Armstrong, C. G. Wilcox and J. S. Chase are the promoters.

The Oshkosh Telephone and Electric Service Exchange, Oshkosh, Wis., capital stock $50,000, has been formed to construct and equip a telephone system. G. Bauman, G. W. Pratt, A. J. Barber, R. B. Evans and B. C. Gudden are the promoters.

The Duplex Electric Trolley Manufacturing Company, Chicago, Ill., capital stock $100,000, has been formed to manufacture and sell electric trolleys and other electrical appliances. E. P. Hovey, J. M. C. Tyner and P. L. Austin are the promoters.

The Milford Light and Power Company, Milford, N. H., capital stock $80,000, has been organized to generate light and power. H. A. Burnham, Gloucester; H. P. Stanwood, H. C. Buck, A. E. Leon, Boston, and W. E. Brigham, Lynn, Mass., are the promoters.

The Madisonville & Cincinnati Street Railway Company, Madisonville, O., capital stock $100,000, has been incorporated to construct and operate street railways to be operated by electric or other power. The promoters are G. W. Losh, C. L. Metz, C. M. Settle, W. H. Settle, James Julien and C. S. Muchmore.

The General Electric and Improvement Company, Jersey City, N. J., capital stock $500,000, has been formed to manufacture and deal in apparatus. K. A. Chandler, E. Orange, C. N. King, Jersey City, N. J., and W. J. Turner, New York City, are the promoters.

Concord Light and Power Company, Concord, N. H., capital stock $200,000, has been formed to generate and distribute electricity and gas in that city and vicinity. H. W. Stevens, A. B. Cross, H. M. Cavis, F. P. Andrews and E. J. Hill, all of Concord, are the promoters.

The Fletcher Webster Gold Mining Company, Seattle, Wash., capital stock $5,000,000, has been formed to operate electric light and power plants, etc. Andrew Hemrich, C. Walker, F. T. Blunck, M. McMicken, G. Collins, G. F. Gund and C. W. Turner are the organizers.

The Electric Construction Company of Virginia, Richmond, Va., capital stock $25,000, has been formed to manufacture electric and other machinery and to supply light, heat and power. A. Pizzini, Jr., W. E. B. Allen, W. B. Poque and C. R. Winston are the promoters.

The Indianapolis & Martinsville Electric Railway Company, Indianapolis, Ind., capital stock $50,000, has been incorporated to erect and maintain a railway. Oscar Matthews, Martinsville, Ind.; B. C. Stevenson and Jas. Stevenson, Indianapolis, Ind., are the promoters.

The Electric Manufacturing Company, Charleston, W. Va., capital stock $10,000, has been formed to manufacture electrical instruments, etc., and to operate telegraph and telephone lines. J. L. Mason, N. B. Ginochio, H. C. Bridges and C. F. Brooks, New York City, are the organizers.

The United Light and Power Company, Georgetown, Colo., capital stock $25,000, has been formed to furnish electric and gas light, heat and power. The incorporators are E. S. Wright, J. S. M. Egan, R. C. Old, F. P. Dewey, P. L. Roberts, F. R. Pneuman, C. S. Desch, all of Georgetown and Silver Plume, Colo.

The Cleveland Electric Railway Company, Cleveland, O., capital stock $12,000,000, has been formed by the consolidation of the Cleveland Electric Railway Company, the Brooklyn Street Railway Company and the South Side Railroad Company. The organizers are H. E. Andrews, M. A. Everett and R. A. Harman.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 8, 1893.

Mr. Henry E. Vincing, of Greenville, N. J., has been appointed electrician of the Brooklyn navy yard.

The Conover Manufacturing Company has moved its offices from 95 Liberty street, New York City, to 39 and 41 Cortlandt street.

The Consolidated Electric Storage Company will hereafter have its offices in the Edison Building, 44 Broad street, New York City.

The Peckham Motor Truck and Wheel Company has moved its offices from 45 Broadway to the new Havemeyer Building, tenth floor.

The Rollason Gas Engine Company, A. A. Bates, Manager, has moved its offices from Dey street to the new Havemeyer Building, sixth floor.

Mr. W. C. Brown, New York manager for the Wainwright Manufacturing Company, of Boston, Mass., has moved his office from 136 Liberty street to 63 Cortlandt street.

Mr. Joseph B. See has recently become the manager of the New York house of the Stilwell-Bierce & Smith-Vaile Company, 112 Liberty street, in place of J. M. Duncan, resigned.

The International Trading and Electric Company, of New York, has removed its offices from the Times Building to larger quarters at 40 Cortlandt street, where it will have better facilities for handling its increasing export business.

Messrs. Hine & Robertson, formerly of No. 57, have moved to 68 Cortlandt street, where they occupy four entire floors. The change to larger quarters was due to the fact of increasing orders for this firm's specialties, which include straight line indicators, Eureka packing, regulators, eliminators, etc.

The New York Electrical Society held its annual meeting at Columbia College on May 5. The secretary's report gave a list of 309 members, a net increase of 17 during the past year. The following officers were elected for the ensuing year: President, Joseph Wetzler (re-elected); vice-presidents, F. B. Crocker (re-elected); Nikola Tesla (re-elected), M. M. Davis, C. E. Emery, Dr. W. E. Geyer, W. J. Jenks, C. O. Mailloux; treasurer, H. A. Sinclair (re-elected); secretary, Geo. H. Guy (re-elected). A very interesting and practical lecture was delivered by Prof. F. B. Crocker on the dynamotor or direct current transformer.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 MONADNOCK BUILDING, CHICAGO, May 6, 1893.

H. H. Markle, of Markle & Harnish, Cincinnati agents for Seimens & Halske, has been in Chicago for some days during the past week.

The Nutting Electric Manufacturing Company has secured new quarters for manufacturing at 128 and 130 South Clinton street, Chicago, and is rapidly recovering from its loss by fire. Preparations are being made for the extensive manufacture of the Nutting arc lamp.

W. W. Griscom, President of the Accumulator Company, Philadelphia; Mr. Pfatischer, electrician; and Chas. Register, superintendent of construction, have been in Chicago for some days during the past week in connection with the concession granted for electric launches to be run on the lagoons at the World's Fair Grounds.

The Star Electric Lamp Company, Chicago, is now taking orders for the new lamp for prompt delivery. The lamps sent out are giving excellent satisfaction, and Mr. Terry and his associates are more than gratified at the evidences of appreciation on the part of the consumers. The new company is to be congratulated on the success so far met with.

The American Electrical Manufacturing Company, 2011-2017 Pine street, St. Louis, is turning out over 1,000 incandescent lamps per day. At the time the General Electric Company undertook to stop the making of lamps, some three months since, this company voluntarily shut down its factory and has only recently resumed operations. The capacity has now been doubled and the increased demand is most satisfactory. The American lamp has a national reputation, and Mr. Nahm and his associates are to be congratulated on the success met with.

Taylor, Goodhue & Ames have just moved into their new store at 348 Dearborn street, Chicago, where, although they are not yet fully settled, their rapidly increasing business can be handled to the best satisfaction of customers. They report an unusually large demand for Wagner power motors, fan motors and their large line of transformers. This company, although but recently in the market for business, has experienced a very flattering demand for its goods and recognition among electrical buyers throughout the entire United States, Canada and Mexico. They are making rapid advancement in development of electric heating and cooking devices under the well known Burton patents, and are now placing upon the market all styles and designs of electric cooking utensils. There have been many practical improvements made in cooking devices, under the Burton patents, over other styles that are at present on the market, and the highest economy is claimed for them.

OREGON CITY, Ore., May 1, 1893.

Weston, Ore., has voted bonds for the purpose of establishing an electric lighting plant.

Eugene, Ore., will soon have a telephone system in operation which will be established by a local company.

President H. M. Byllesby, of the Northwest General Electric Company, of St. Paul, was recently in Portland on a tour of inspection.

The Armory of the local militiamen has been wired, and will be lighted free of charge by the Portland General Electric Company, by the kindness of Mr. P. F. Morey.

Chas. S. Bowie has installed an Edison incandescent plant in the new Pierce county court house in Tacoma, Wash. Two 500 light machines are driven by an 80-h. p. Ball engine.

The City and Suburban Railway Company, of Portland, has laid a double track across the bridge on East Morrison street, at East Eighth, and will extend it to Sunnyside later on.

The Canadian General Electric Company has completed the work of constructing and equipping an electric railway, and also of putting in an electric light plant in Brantford, Ont.

The contract for the electric light chandeliers, brackets and fixtures for the new Pierce county court house has been let to the F. W. Hicks Mantel, Tile and Grate Company, of Tacoma, for $4,816.

Spokane, Wash., has another projected electric railway line backed by local capitalists who expect to build a line to Granite Lake, nine miles west of the city, where they will establish a summer hotel.

Lewis & Co., of Chicago, have obtained a location in this city for their plant for the reduction of refractory ores by an electrical process. They are remodeling a building for this purpose and expect soon to receive ore from Eastern and Southern Oregon.

The Portland & Vancouver Railway Company, of Portland, Ore., is being electrically equipped, cars are expected to be running within two months. The gauge of the track will be widened. Ten cars are being built in Portland for use on this line.

The Corriveau-Williams syndicate has secured the electric railway franchise from the Council of St. Louis de Mile End, but there is likely to be considerable litigation over the matter, as the Montreal Street Railway Company claims to have legally received the franchise at a former meeting.

Dr. Louis Bell, of the General Electric Company, recently visited Oregon City and inspected the Portland General Electric Company's water power electric plant, from which 3,000 h. p. is transmitted to Portland, Ore., a distance of 15 miles, at an E. M. F. of 5,000 volts. Dr. Bell expressed himself as favorably impressed with the plans of the new station, which is in course of construction.

The East Side Electric Railway Company will soon increase its service between Oregon City and Portland, making trips every half hour. New cars 38 feet in length, with a capacity of 52 passengers, will be placed on the line. The combination cars now in use were built by the Columbia Car Company, of Portland. The railway company has completed a telephone line for car dispatching, etc.

The Barnes Heights & Cornell Mountain Electric Railway, of Portland, Ore., was recently opened for traffic, the cars making hourly trips. The company has its own power station and successfully operates its cars, overcoming a 7¾ per cent. grade for a distance of two miles. It connects with the Washington street line of the Portland Consolidated Railway Company at the new city park.

The Portland General Electric Company has completed its coffer dam at the basin, where the ten headgates will be put in place to regulate the supply of water to the new electric station in Oregon City. The company has commenced the erection of its office and depot building at this point, which will be used in connection with its West Side electric railroad now in course of construction. This company recently obtained permission to erect a pole line through the eastern outlying districts of Portland and work is being pushed rapidly. Many new residences in those sections have been wired.

CANADIAN NOTES.

OTTAWA, May 6, 1893.

Nanaimo, B. C.—A San Francisco firm has offered to install a plant and place in thorough running order an electric railway between this city and Wellington for $30,000.

The Kingston (Ont.) Street Railway Company is applying to the Ontario Legislature for an amendment to its charter, asking for power to use electricity, to alter its gauge, and to run its lines on new streets.

Harvey Cortland, E. A. Spears, of Toronto; W. H. Comstock, C. C. Cossitt, and G. J. Mallory, of Brockville, have been incorporated as the Cortland Electrical Manufacturing Company, Limited, with a capital of $40,000.

The Automatic Telephone and Electric Company, of Canada, with headquarters at Montreal, has secured a charter whose provisions are causing no little anxiety to existing corporations in that line of business. The new company's charter is a very generous one.

Ottawa, Ont.—The Ottawa Electric Railway Company has made a proposition to the Hull City Council in connection with the scheme to extend its road to that city, to pay $100 a mile for the first 15 years; $200 for the next 10 years, and $300 for the following 10 years, at the end of which time the charter will expire.

The Montreal Street Railway Company has in course of construction a temporary power house, to be used until the permanent one is ready, which will be before the end of the year. The temporary construction is costing $30,000. It will supply an extra 1,000 h. p. from the beginning of May, and will be kept in reserve after the big one is completed. New rails will be laid on St. Catherine street this summer, the work to be commenced within a couple of weeks.

The Street Railway Company of Montreal has unearthed a big robbery scheme among its conductors. For four months the company has been systematically robbed by conductors who have invented a tin slide by which means money and tickets were taken from boxes. A few purchased all the tickets they could get hold of at a cheap rate and resold them. Thirty conductors were recently dismissed. The company has established a secret service in connection with its lines.

Toronto.—The next month or two promises considerable activity in the construction of suburban electric railways. The Toronto & Scarboro Company has let the tenders for equipment to the Canadian General Electric Company. Barlow Cumberland's electric railway company is just now in statu quo, but it is expected that operations will be recommenced shortly. Owing to a breakdown in the equipment, and a disagreement with the company which supplied it, the road has not been running for some time.

St. John, N. B.—Messrs. Chas. D. Jones and A. R. Bliss, of the Consolidated Electric Company (Limited), were in Amherst recently, and effected an arrangement with the Canada Electric Company for the purchase of their entire electrical manufacturing equipment. This will be shipped from Amherst in a few days, and it is the intention of the company to erect the machinery in the building now occupied as a car shed on Main street, Portland. When everything is in readiness the company will have the only electrical manufacturing plant east of Montreal.

A new source of trouble, and one that may become serious, has come to the attention of the officials. Before the introduction of the electric street railway system lead pipes, such as are used in introducing water from the service mains into the houses, were considered good for ages. It was thought that in ordinary use they would practically never wear out, but numerous breaks and leakages recently occurring have led to an investigation, and it has been found that where the pipes are close to the poles of the trolley system they become eaten out in a very short time. Within a very short time Foreman Anstey and his men have had to put in the whole or parts of seven new services in the vicinity of the street railway company's power house.

Edwin Rochester, of Ottawa, Ont., has patented an invention which provides a fender to be placed on electric cars. The invention consists of a series of wooden fingers attached to a frame at the front of the car. Each finger is suspended from a hanger and rearwardly attached to a spring, so that when a finger meets an obstruction the finger recedes and rises at the same time, allowing the feeder to pass over it. The finger receding forms a cushion to receive the falling body, whether animate or inanimate. A flexible cushion extending the whole length of the series of fingers prevents the body from passing under the car. The car has also wire guards at the sides to protect the car wheels. Each of the fingers at the front carries a rubber roller, and the finger runs about an inch above the rail.

Peterboro, Ont.—The rails for the new electric street railway in this city have been ordered from England, and are being shipped now. The motor and electrical appliances for the road are being macufactured at the works here. Tenders have been advertised for by the company for the grading and tracklaying. The company will furnish all the necessary supplies and equipments for the road, and operate it when completed. The grading, tracklaying and pole setting will alone be done by the contractor. The Canadian General Electric Company, which recently received the town franchise for an electric street railway, has amalgamated with the Peterboro & Ashburnham Railway Company under the charter of the latter for the purpose of constructing and operating the road.

The new power house of the Ottawa Electric Street Light Company is completed and is one of the most complete of its kind in America. With the power at their command the company can now supply 1,000 arc lights. The dimensions of the new building are 113 × 50 feet of solid stone. The street lights are run by two 60-inch wheels, and now a third wheel is being put in the centre of equal size, to be held in reserve. These three wheels are of 300 h. p. each. The commercial lights are run on a separate system and get power from a 48-inch wheel of 110 h. p., which drives three dynamos. At present the running capacity is 710 h. p., without the 310 h. p. reserve wheel, and wheel pits have been built for 1,200 h. p. more. The company will then be able to more than double the present number of city lights. In the dynamo room upstairs there are one 50-light machine, seven 35-light machines, seven 25-light, three 40-light and one 15-light machine for the station and shop, making a total of 635 lights.

Niagara Falls, Ont.—The work now going on in connection with the Niagara Falls Park & River Electric Railway presents a busy sight. The undertaking to construct the wheel pit and drive the tunnel to the river bank underneath the falls was no meagre undertaking. The tunnel is 600 feet long and 8 by 10 feet in size. It discharges the water from the wheels a little way out from Table Rock. The wheel pits are 80 feet deep and large enough for three horizontal turbines of 1,000-h. p. capacity each. The inlet canal, which is 250 feet long, 14 feet deep and 18 feet wide, is now under construction. It will take water from the river at the foot of Cedar Island, at the bridge crossing to the mainland. The water will be brought into a large basin, from which it will be conducted in large iron penstocks 7 feet 6 inches in diameter. The size of the electrical power house located just above the Falls and opposite the foot of Cedar Island on the main shore will be 100 feet by 62 feet. When completed the building will consist of one large room in which will be the main shaft and three dynamos of 250 h. p. each. A bay over the water basin will be built on to the main building, 25 by 45 feet in size. There will be but three dynamos placed at first. This will give 750 h. p. These, as well as the two which will be placed in the Queenston power house, will be constructed by the Canada General Electric Company, of Toronto. The building will be a frame structure, 100 by 35 feet in dimensions. It will be divided into a boiler room, 35 by 30 feet, and an engine room 55 by 70 feet. The foundations have already been laid, and the building framework is going up. This plant will be equipped with two Wheelock engines of 150 h. p. each, made by the Goldie & McCulloch Company, of Galt, Ont. The dynamos will be of 200 kw. capacity. This power will be used exclusively to drive the cars up the heavy grade on the mountain, which is a mile and a half long, and an incline of 250 feet to the mile. It is the intention of General Manager Grant and the directors of the road to open it on May 24.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, April 19, 1893.

Board of Trade Regulations in Connection with Alternating Current Supply.—The Board of Trade has favored the electrical industry with yet another "ukase." This document states that the Board of Trade having been empowered by the electric lighting acts and provisional orders under it to make regulations for the safety of the public, in order to prevent high pressure alternating currents finding their way into house or low pressure networks, it approves for that purpose of a device such that "by the construction and winding of the apparatus any wire or other conductor forming part of the low pressure supply circuit within the transforming apparatus is separated from any wire or other conductor forming part of the high pressure supply circuit within the transforming apparatus in every part by a wire or other conductor possessing sufficient sectional area, which is efficiently connected to earth, but is not in metallic connection with either the high pressure or low pressure supply circuits." This appears to be an approval of the suggestion made by Mr. Mordey some years ago of separating the primaries and secondaries of transformers by a copper sheet or other conductors connected to earth.

Metropolitan Electric Supply Company.—The report of the Metropolitan Electric Supply Company, which has just been published, is perhaps of more interest than that of any other company in the United Kingdom to the electrical supply industry; for not only is this company by far the biggest concern of its kind in every way except that of paid up capital, in which it is exceeded by the London Electric Supply Corporation, but the character of its district is very varied in different parts and the company possesses also a large variety of steam and other machinery. At the present moment, moreover, when the low pressure continuous current men appear to be gaining the day, the demonstration of the Metropolitan Electric Supply Company that an alternate current supply undertaken under by no means favorable circumstances and—for reasons beyond the control of the directors—in a somewhat haphazard manner, can be made to pay, is valuable. The dividend of 3 per cent. is scarcely handsome, but, like the rest of our London companies, the Metropolitan continues steadily to increase its lamp revenue and to decrease the absolute cost of production of the Board of Trade unit. In 1891 the sale of current brought in about £38,000, last year the figure was £51,000, an increase of over 34 per cent. The *total* expenses of production have only increased by 2.7 per cent.; all items save coal and repairs showing an actual diminution. It is obvious that if this process is continued long enough a handsome dividend paying stage must be reached. The capital expenditure of this company is £550,000 and it is proposed to raise immediately another £50,000.

News of the Week.

THE ELECTRIC LIGHT.

The Cohasset (Mass.) Electric Company has recently put in an 80-h. p. single cylinder Ball engine to furnish power for house lighting.

Lebanon, Pa., has decided to establish a $20,000 electric light plant.

Roseville, Ill.—The new Village Board is in favor of electric illumination.

High Falls, N. C., has under consideration the establishing of an electric light plant.

Danvers, Mass., has voted the sum of $11,000 for increasing the capacity of its electric light plant.

Phœnix, N. Y.—The Gardner Electric Company has applied for a franchise for electric lighting.

The Waxahachie (Tex.) Electric Light Company is to double the capacity of its plant and issue $15,000 in bonds

Huntington, L. I.—Another electric company has been formed, in which W. Lindsay, J. A. Smith, A. B. Gildersleeve and A. F. Aitkin are interested.

Harper's Ferry, W. Va.—The local authorities have signed a contract with an electric lighting company which provides that a plant shall be erected within 90 days.

St. Paul, Minn.—Bills have been signed appropriating $3,000 for the electric light plant for the Asylum for the Blind and $7,000 for a lighting plant for the School for the Feeble Minded.

The Dover Electric Light Company at its annual meeting elected the following officers: D. S. Allen, president, and I. W. Searig, secretary, and decided to make improvements in its plant.

The Oxford (Pa.) Electric Light and Power Company has increased its plant to 1,200 lights capacity, and expects to move into its new building June 1, when it will commence the lighting of the town.

Mr. C. O. Baker, the popular master of transportation of the National Electric Light Association, accompanied by Mrs. Baker, arrived in New York a few days since after a five weeks' trip abroad. Mr. Baker looks much benefited by his vacation.

Baltimore, Md.—At the next meeting of the Council an ordinance will be introduced asking the Legislature to pass an act permitting the city of Baltimore to employ a plant for lighting streets by electricity, and authorizing a loan sufficient to defray the cost thereof.

The Northwestern Water and Light Company, of Le Mars, Ia., has been organized and has acquired the plant hitherto operated by J. H. Winchell. The officers of the new company are J. H. Winchell, president; M. W. Richey, vice-president, and J. K. Atline, secretary and treasurer.

The Genesee (Idaho) Electric Light & Power Company is now in its new station, which is equipped with a 100-h. p. Buckeye engine, two Edison incandescent dynamos and one American Brush arc dynamo. The officers of the company are: President, D. B. Grant; vice-president, W. Harris; secretary, C. F. Burr: treasurer, L. K. Krun; manager, H. Sampson; electrician and chief engineer, Oscar Erickson.

THE ELECTRIC RAILWAY.

Dansville, N. Y.—S. N. Blake, of Elmira, is the president of the company which will build a street railway in Dansville.

The Northampton (Mass.) Electric Railway will issue $100,000 worth of stock for the extension of its new road.

The White Electric Company has applied for a franchise for an electric line from Atlanta, Ga., to McPherson Barracks.

The Citizens' Light, Heat and Power Company, of Dover, Del., has been authorized to construct an electric railway.

The Terre Haute (Ind.) Electric Railway has been purchased by a new company which will make an eight-mile extension.

Muskegon, Mich.—A stock company has been organized to construct an electric railroad to Hackley Park Assembly Grounds, the road to be in operation by Aug. 1.

Chester, O.—J. B. Robinson and others have secured a charter for an electric road between Chester and Media, Glen Riddle and other points along the Chester railroad.

Vicksburg, Miss.—The Hill Street Railway Company and the Vicksburg Street Railway Company will consolidate, and the new company will equip its lines with electricity.

A. D. Ogborn, of Newcastle, Ind., representing a number of others, has secured franchises and right of way to build an electric railway between and through the cities of Dunkirk and Redkey, Ind., and to put in an arc and incandesent plant in each place. He has contracts for a forty 2,000-c. p. arc light plant, in each city and the railway will be five miles in length. A survey of the line is now being made, and when completed full specifications for the entire plant will be prepared and bids asked.

LEGAL NOTES.

Contributory Negligence in Obstructing Track.—Where one, after dark, obstructs an electric street car track with his team while unloading his wagon, he is guilty of such negligence as will bar an action for the injuries to the team from a car, though it was more convenient to unload the wagon in that position than in any other.—(Winter v. Federal St. & P. V. Pass. Ry. Co., Supreme Court of Penn., 25 At. Rep., 1,028.)

Congratulations from Abroad.—Prof. Elisha Gray, of Chicago, has received the following cablegram dated Whitehall Club, London, May 5, 1893, and signed by W. H. Preece: "The electrical engineers of England dining together at their club tonight desire to convey to their professional brethren in Chicago sincere congratulations upon the opening of their grand Exhibition. We hope to appear in person August next to support the success of your magnificent undertaking."

Rights Under Purchase of an Option.—Defendant purchased an option from a patentee of electric motors, and before its expiration entered into an agreement for an extension thereof; defendant "to furnish the necessary funds to construct four sample motors," and the option to be extended 30 days, "or until such time as the motors are completed and tested, providing sufficient means are promptly furnished and facilities are provided for such tests." The Supreme Court rules, where plaintiff constructed the motors on an order from the patentee that he had no right of action against defendant for the cost thereof on the latter's option agreement.—(Morgan Engineering Company v. McKee, 25 At. Rep., 800.)

Power of Cities to License Telegraph Companies.—A license tax of one dollar per year for each telegraph pole erected in a city, imposed by ordinance, is not so unreasonable as to justify the Supreme Court in interfering with the discretion of the municipal officers. The fact that such license tax may be in excess of the usual and ordinary expense of municipal officers in issuing the license, and the expense thereby imposed on the municipality, is not sufficient to warrant the court in interfering in the absence of any showing as to the extent of liability imposed upon the city by the erection of the poles, such as inspection, to relieve the city from liability from negligence in case of injuries to person or property.—(City of Chester v. W. U. Tel. Co., Supreme Court of Penn., 25 At. Rep., 1,134.)

MISCELLANEOUS NOTES.

Italian Honors to Sir William Thomson.—Lord Kelvin has been nominated by the Italian Minister of Public Instruction as a member of the Naples Academy.

The American Mechanic Publishing Company has changed its office from Minneapolis to the Gaff Building, 230-236 La Salle street, Chicago, Ill. Mr. Thomas P. Pemberton, late of the *Master Steam Fitter and Stationary Engineer*, will have charge of the *American Mechanic* as managing editor.

Mr. E. S. Snedeker, the inventor of the Salamander fireproof wire, has been giving some tests of his wire in London, Eng., where as much interest was manifested as in the remarkable tests in New York, reported in the columns of THE ELECTRICAL WORLD. Many prominent men witnessed the tests, Mr. W. H. Preece among others.

Our enterprising contemporary, the *Western Electrician*, has gotten out a World's Fair opening issue, largely devoted, as the name suggests, to Exposition matters, and containing a number of contributions from those who have been most prominently identified with its engineering features, with a variety of interesting illustrations. The issue reflects much credit upon the editors and publishers.

Mr. F. A. Scheffler, who on April 1 resigned his position as superintendent of the Brush Electric Company's factory at Cleveland, O., has been appointed general sales agent of the Stirling Company, manufacturer of the Stirling water tube boiler, with office at 74 Cortlandt street, New York City. Mr. Scheffler's wide experience in the electrical business will enable him to appreciate what is required in the mechanical line for electrical work.

The Sprague Elevator Company is erecting large works at Wateessing Junction on the Delaware, Lackawanna & Western and Erie railways, about eight miles from Newark, N. J. Several acres of ground have been purchased, and the first shop, which will be ready for occupancy in a few months, is 250 feet long and 125 feet wide, with a capacity of 200 elevators per year. This shop is being equipped with a large electric traveling crane, and electricity will be used for power everywhere throughout the works, an electric power house capable of supplying the present and future needs of the works being now in process of construction.

Trade and Industrial Notes.

The Backus Water Motor Company, Newark, N. J., has changed its name to the Backus Manufacturing Company.

The partnership heretofore existing between Anderson and Goddard, of Ottawa, Can., has been dissolved, and the business will be continued by Mr. R. Anderson at 128½ Sparks street, Ottawa.

The Mica Insulator Company, 218 Water street, New York City, reports increased sales for its Micanite insulators, which are now being used by the largest electrical street railways for repairing motors and generators.

The Garton-Daniels Electric Company, Keokuk, Ia., reports a very brisk demand for the Garton lightning arrester, which it manufactures, and which is claimed to give absolute protection to street railway apparatus and motors.

The Ball Engine Company, Erie, Pa., has recently closed a contract for a 500-h. p. cross compound engine with H. F. Watson, paper manufacturer, Erie, Pa.; and a 200-h. p. single cylinder engine for the Bradford (Pa.) Electric Light Company.

The C. & C. Electric Motor Company, 402-404 Greenwich street, New York City, recently made arrangements to open a branch office in Philadelphia, at No. 42 North Seventh street, under the management of Mr. Geo. H. S. Young. This office was opened May 1.

The Akron Electrical Manufacturing Company, Akron, O., has received a testimonial from Philip Francioli, of Memphis, Tenn., expressing his satisfaction with the 250-light 110-volt Akron dynamo installed in his hotel in November, 1892. He is particularly pleased with the slow speed self-oiling bearings and automatic regulation.

The Woods new adjustable switch, recently placed on the market by the Ansonia Electrical Company, formerly the Electrical Supply Company, of Chicago, has met with favor. This switch is made with adjustable tongues which will allow it to be used as a right, left or diamond turnout, and is constructed of the very best materials.

The General Incandescent Arc Light Company, 59 Duane street, New York City, has secured the agency for the United States and Canada for the arc light carbons and carbon brushes manufactured by the Fabrik Electrischer Beleuchtungskohlen, in Nürnberg, Actiensgeseilschaft vormals Ch. Schmetzer, and is thus enabled to supply a very high grade of carbons.

Messrs. Howson & Howson, solicitors, of Potter Building, 38 Park Row, New York City, announce that Mr. Robert F. Frazer has been appointed manager of their Washington office, which has been removed to the National Union Building, 918 F street, Washington, D. C. Mr. Frazer is a graduate of the Naval Academy, and has had an experience of five years as examiner in the Patent Office.

The Buckeye Electric Company, of Cleveland, has reopened its factory and is turning out a large number of lamps. The company has a great many orders on hand, but is in excellent condition to handle additional orders. The Buckeye lamp has always been a great favorite, and Mr. Rockwell in Cleveland and Mr. Cooke in Chicago will do their best to see that the lamp continues to merit the praise it gets.

Taylor, Goodhue & Ames, Chicago, are getting their exhibit in Electricity Building at the World's Fair rapidly near completion, and will shortly have an interesting display to show to visiting electricians. Their alternating current motor will be especially worthy of careful attention, and will, no doubt, excite considerable interest among all those who have an eye toward the development and utilization of the alternating current.

The Phœnix Iron Works Company, Meadville, Pa., has recently sold to the Saginaw (Mich.) Power Company two 300-h. p. Dick & Church tandem compound engines, which will each be coupled directly to a 200-k w. generator. This company has also sold the Wyandotte & Detroit River Company another compound engine of 150 h. p. capacity, and has closed a contract for eight horizontal tubular boilers for the street railway plant at Allentown, Pa.

The Wolverton Electric Company, Rahway, N. J., consisting of Geo. Wolverton, John E. Lloyd and Perry E. Wolverton, who have been connected recently with leading electrical engineers and electrical manufacturing concerns, have opened their shop to do repairing of electric light and power apparatus, railway generators, street car motors, armatures, field winding, etc., with improved machinery for first class work. All of the members of the firm are experienced, practical electricians, which will no doubt be appreciated by the trade.

The Buffalo Electric Construction Company, Buffalo, N. Y., has made the following recent sales and installations: Wally Building, Buffalo, 600-light Canton Electric Company dynamo and Rice automatic engine; there will be 150 lights on the outside of the building, 75 lights in the form of a canopy over a large front window; the arc lights will be in series, ornamental style, with a 1,000-c. p. search light in a revolving glass tower on top; a plant for Kinney & Sharer, Buffalo, 50-light Canton Electric Company dynamo with boiler and engine complete; and several other large orders under way.

W. F. Breidenbach, who formerly represented Alexander, Barney & Chapin, resigned his position to accept one with the F. P. Little Electrical Construction and Supply Company, of Buffalo, N. Y. Mr. Breidenbach has many friends in the electrical business, and will, no doubt, meet with success. The F. P. Little Electrical Construction and Supply Company has found its business so much increased that it has been necessary to make another addition to its force, and has also secured Mr. D. F. Potter, formerly with the General Electrical Company, of Syracuse, who will assist in the general engineering and construction work.

The F. P. Little Electrical Construction and Supply Company, of Buffalo, N. Y., is very busy in its various departments manufacturing, repairing and shipping electric light plants to the different parts of the country. It has recently done considerable marine work, including a complete plant with a D 7 200-light dynamo on the Nyack steamboat; a 150 light dynamo and equipment on the Mohawk steamboat, Detroit, and is also overhauling and repairing the electric light equipment on 11 steamboats on the Northern steamboat line. The company has also installed a complete plant of 1,200 lights in the Globe Hotel, Albany, and is now wiring the Albany club house.

L. J. Wing & Company have recently made installations of their ventilating plants or Wing disc fans in the following places: New York Electric Equipment Company, New York; New York *Press*, New York; Paris Electric Light and Railway Company, Paris, Tex.; Reuter & Mallory, Baltimore, Md.; W. H. Tolhurst & Son, Troy, N. Y.; Leonard & McCoy, New York; Crawley & Johnston, Cincinnati, O.; General Electric Company, New York; Western Union Telegraph Company, New York; St. Denis Hotel, New York; Grenoble Hotel, New York; Murray Hill Turkish Bath, New York; Mount Morris Electric Light Company, New York; A. W. Dennett, Philadelphia, Pa.; the Bingham House, Philadelphia, Pa; McNeely & Company, Philadelphia, Pa.; Stevens Manufacturing Company, Fall River, Mass.; American Stamping Company, New York; Fourth National Bank, New York; Bradley & Hubbard Manufacturing Company, Meriden, Conn.; Thompson & Norris Company Brooklyn, N. Y; Welz & Zerwick Brewery, Brooklyn, N. Y.; William Teschemacher, silk dyer, Brooklyn, N. Y.; McLeod, Ward & Co., New York; E. D. Garratt & Co., Galveston, Tex.; Blackmore Heating Company, New York; Jas. Curran Manufacturing Company, New York.

Warren Webster & Co., 491 N. Third street, Philadelphia, Pa., manufacturers of the Webster vacuum feed water heater and purifier for utilizing waste exhaust steam, booked orders from the following firms during the months of March and April: Wm. Wood & Co., Philadelphia, Pa.; Aldrich & Wormstead, Buffalo, N. Y.; Boughen Engineering Company, Cincinnati, O.; J. G. Brill & Co., Philadelphia, Pa.; Hammond City Water Works, Whiting, Ind.; Oval Wood Dish Company, Traverse City, Mich.; Hotel Windsor, Bloomington, Ill.; John L. Roper Lumber Company, Norfolk, Va.; Geerin Brothers & Co., Cincinnati, O.; Philadelphia Gas Improvement Company, Philadelphia, Pa.; Oliver Iron and Steel Company, Pittsburgh, Pa.; Mr. E. D. Simmons, Reading, Pa.; Water and Light Company, Nebraska City, Neb.; Armour Institute, Chicago, Ill.; Youngstown Street Railway Company, Youngstown, O.; Grosvenor Dale Company, Grosvenor Dale, Conn.; New England Electrolytic Copper Company, Central Falls, R. I.; Carnegie Steel Company, Munhall, Pa; Luray Artistic Wood Company, Luray, Va.; Swift & Co., National Stock Yards, St. Louis, Mo.; Hooper & Townsend, Philadelphia, Pa.; Swift & Co., South Omaha, Neb., and Ertel Brothers, Williamsport, Pa. They expect to move into their new works in about two months.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filters for sale cheap. Prices on application to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED MAY 2, 1893.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

496,402. Musical Instrument; Richard Eisemann, Berlin, Germany. Application filed Jan. 21, 1893. In a musical instrument having vibrating wires or plates, an electromagnetic sound generating and sustaining device comprising an electromagnet acting to vibrate the wires, an electric circuit for supplying an electric current to the magnet, and a microphone installed in the circuit for controlling the current traversing the magnet, whereby the vibrations of the microphone cause undulations in the current actuating the magnet and thereby the action of the latter is controlled.

496,409. Electric Arc Lamp; Fritz Hansen, Leipsic-Reudnitz, Germany. Application filed Dec. 13, 1892. Upper and lower carbon holders in combination, a pivoted electromagnet, an armature therefor, and a connection between the electromagnet and one of the carbon holders, the connection extending from a point to one side of the pivots of the magnet.

496,427. Electrically Operated Overhead Traveling Crane; W. H. Morgan, Alliance, O. Application filed July 22, 1891. In combination with an electric motor, a gravity brake, an electromagnet in the motor circuit acting on the brake to hold it out of operation when the motor circuit is closed, and means for actuating the brake mechanically.

496,428. Locomotive Crane; W. H. Morgan, Alliance, O. Application filed Nov. 25, 1891. In a jib crane, the combination

with a truck mounted on wheels, a movable platform on the truck, a jib, and hoisting mechanism, a movable counterpoise on the platform, and a motor carried by the counterpoise for moving the latter.

496,429. Gravity Brake for Vehicles; W. H. Morgan, Alliance, O. Application filed Nov. 2?, 1891. In a gravity brake the combination with an electric motor and brake wheel, of a gravity brake consisting essentially of a pivoted lever connected at its short arm to a suitable friction device and carrying an armature on its long arm, and an electromagnet located above the armature, the electromagnet being in the motor circuit and adapted to act on the armature to hold the brake out of contact with the brake wheel when the motor circuit is closed.

496,430. Locomotive Jib Crane; W. H. Morgan, Alliance, O. Application filed May 10, 1892. In an electric crane the combination with a truck, a rotary platform thereon, a motor on the truck and a motor on the platform and a trolley pole secured to the truck in line with the axis of the rotary platform.

496,432. Magnetic Crane; W. H. Morgan, Alliance, O. Application filed June 9, 1892. In an overhead traveling crane, the combination with a traveling bridge, a series of drums thereon, and means by which the drums can be rotated independently or in unison, and of a magnet suspended from each drum.

496,433. Pillar-Crane; W. H. Morgan, Alliance, O. Application filed June 13, 1892. In a jib crane, the combination with a standard and a jib, and a motor and drum carried by the jib, of an electric conductor and sliding contacts between the conductor and motor.

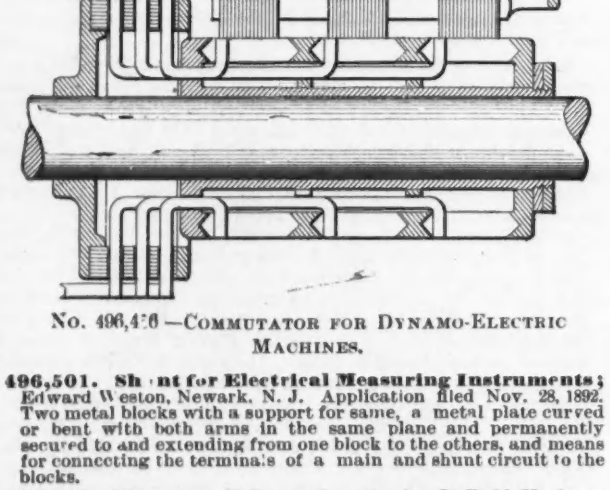
496,449. Perforated Pole Piece for Dynamo-Electric Machines; Charles E. Scribner and Ernest P. Warner, Chicago, Ill. Application filed Feb. 7, 1890. A dynamo-electric machine having consequent pole pieces cut away or perforated on a line coincident with a plane passing through the axis of the armature shaft, such perforations being symmetrical with regard to the plane, regardless of the direction of the rotation of the armature.

496,455. Electric Lighting System; Elihu Thomson and Edwin Wilbur Rice, Jr., Lynn, Mass. Application filed April 14, 1884. A group of translating devices arranged in multiple arc, a set of equivalent resistances, switch devices in each multiple arc branch for substituting the resistances automatically upon the breaking of the individual branches, a normally open branch around the group of translating devices, and an electromagnetic switch whose coils are in the main line circuit, the switch being adjusted to close the latter branch on an increase of the main current to an abnormal extent.

496,456. Commutator for Dynamo-Electric Machines; Elihu Thomson, Swampscott, Mass. Application filed Dec. 2, 1891. The combination with the commutator and its connections of the laminated mass of magnetic material in inductive relation to such connections. (See illustration.)

496,473. Automatic Railroad Signal; William Daves, Jersey City, and Wm. H. Peddle, Roselle, N. J. Application filed Sept. 7, 1892. An electric bunch-light for theatrical and similar purposes, comprising a standard, a plurality of lamps fixed to the front of the standard and connected severally to the lamps, connections to the poles of an electric circuit, and a plate sliding in ways on the back of the standard, and adapted to throw the lamps in succession in or out of the circuit.

496,500. Electrical Measuring Instrument; Edward Weston, Newark, N. J. Application filed Feb. 17, 1892. A permanent magnet, a loop conductor rotary on a diametrical axis and disposed between the poles of a magnet, the conductor being in main circuit, a contact arm carried by the conductor and a contact stop or point in the field of movement of the arm, the stop being in separate or relay circuit.



No. 496,456.—Commutator for Dynamo-Electric Machines.

496,501. Shunt for Electrical Measuring Instruments; Edward Weston, Newark, N. J. Application filed Nov. 28, 1892. Two metal blocks with a support for same, a metal plate curved or bent with both arms in the same plane and permanently secured to and extending from one block to the others, and means for connecting the terminals of a main and shunt circuit to the blocks.

496,513. Vibratory Telegraphy; Stephen D. Field, Yonkers, N. Y. Application filed July 30, 1892. A system provided with means for imposing rapid electrical vibrations on lines connecting two or more stations, the means comprising a thermic vibrator for varying the resistance of a local circuit, including the primaries of two or more induction coils, the secondaries of which charge the line, a bridge wire connecting the thermic wire with a point between the primaries, and an electric generator on each side of the bridge wire.

496,514. Armature for Dynamo-Electric Machinery; Waldemar Fritschie, Berlin, Germany. Application filed Dec. 2, 1892. An armature for dynamo-electric or other machines having its core and winding formed of a series of electrically interconnected and radially arranged conductors, and a hub to which they are secured, in combination with a commutator segment at the outer ends of alternate radial conductors and insulators interposed between the commutator segments.

496,517. Manufacture of Electrodes for Primary or Secondary Batteries; Rudolph T. E. Hensel, Dresden, Germany. Application filed June 17, 1892. A material for use as a cement for battery electrodes comprising an acid, gelatine and an alkali.

496,522. Controlling and Equalizing Electric Motors; David Mason, Schenectady, N. Y. Application filed April 22, 1892. The combination with several motors of switch apparatus for controlling same, the apparatus having contact devices so arranged as to connect the coil of the motors in series alternately.

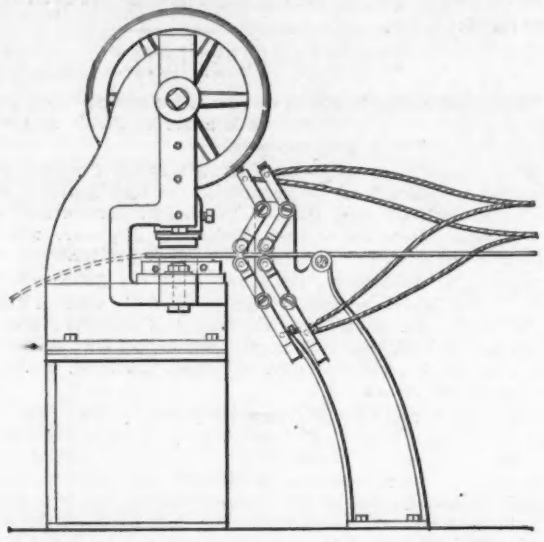
496,537. Electric Distribution System for Railways; Nelson W. Perry, Cincinnati, O. Application filed May 27, 1891. The combination in a system of electric distribution for moving translating devices of outgoing feed wire, an incoming feed wire, two sectional working conductors, lapping but normally insulated from each other; branch feed wires normally broken, connecting the outgoing feed wire with the sections of one of the working conductors, and the incoming feed wires with the section of the other working conductor; switches adapted to close the breaks in the branch feed wires, magnets controlling the switches; supplemental conductors adjacent to each end of the sections of the working conductors and a connection from the supplemental conductors at the ends of a section of the working conductor through the switch controlling magnet to the return.

496,549. Printing-Telegraph Instrument; Alexander H. Wirsching, Brooklyn, N. Y. Application filed June 8, 1892. The combination of two type wheels, a wheel-operating mechanism, two printing pads, a single printing lever and its electromagnet, interchangeable tappets on a common pivot of the printing lever, adjusting pawls also on this pivot in fixed relation to the tappets, an anchor lever engaging alternately with either of the pawls by one of its arms, and means for shifting the anchor lever by the type-wheel shaft.

496,550. Electric Locomotive; Eben Moody Boynton, West Newbury, Mass. Application filed Dec. 7, 1891. In an electrically propelled vehicle, the combination with the driving wheel of an armature fastened to the web of the wheel and acted upon by field magnets, so joined by their pole pieces that they together form a polygonal structure, which is fastened to the motor frame and in which the axis of the field magnet coils are tangential to the circle inscribed in the polygon, having its centre in the axis of the armature.

496,567. Utilizing Electric Motors for Operating Machinery; Carl Hoffmann and Ernst Richter, Berlin, Germany. Application filed Nov. 7, 1892. The combination with a power machine of a movable frame carrying transmission gearing for driving the power machine, and a pivotally supported electric motor suspended by its driving belt from the frame gearing.

496,591. Apparatus for Making Blanks by Electricity; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed Feb. 20, 1891. The combination of a standard, two upper lateral arms extending therefrom, two lower lateral arms extending therefrom, a lateral arm on an intermediate plane, two pivoted electrodes depending from the upper arms, two weighted electrodes pivoted to the lower arms and extending upward, a feed roll on the intermediate arm, and electrical conductors connected with the arms and the source of electricity. (See illustration.)



No. 496,591.—Apparatus for Making Blanks by Electricity.

496,592. Working Brass by Electricity; George D. Burton, Boston, Mass. Application filed Sept. 28, 1891. An electric metal heating apparatus consisting of a frame, a tapering expansible socket the sides of which are composed of superimposed metallic spring plates attached to this frame, and lateral springs interposed between the tapering socket and the frame.

496,593. Electric Forge; George D. Burton, Boston, Mass. Application filed April 15, 1892. The combination of conductors for conveying an electric heating current, pipes for surrounding the conductors for conveying a cooling fluid thereto and a fluid forcing apparatus connected with the pipes.

496,594. Electric Forge; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed May 3, 1892. This invention consists of two standards connected with opposite electric poles, jaws in these standards, movable jaws supported in the standards, toggle levers connected with the movable jaws, and actuating levers connected with the toggle joints of the toggle levers.

496,602. Electric Signaling Apparatus; Stephen D. Field, Yonkers, N. Y. Application filed Jan. 23, 1893. A signaling apparatus for vibrating or undulating currents comprising a conductor supported in a magnetic field and mechanically connected with an inharmonious vibrator, the apparatus being normally in a state of stress.

496,611. Automatic Safety Switch; Adelbert E. Hutchins Detroit, Mich. Application filed Dec. 22, 1892 In the apparatus, the combination with the pivoted arms arranged to be held in electric contact of the arms connected with an idle wire and adapted to transfer the current from arms to said idle wire.

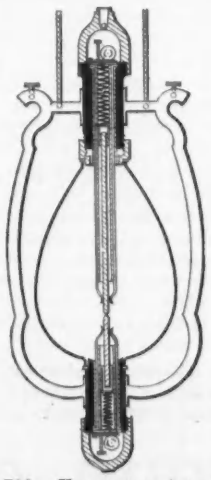
496,618. Electric Gas Lighter; David J. Quinn, Brookline, Mass., and Paul W. Hoffman, Boston, Mass. Application filed June 20, 1892. A gas burner, a rotatable valve therefor, a spring tensioned pivoted spark arm and co-operating fixed contact therefor, a segment on said valve, stops limiting the movement of said valve in either direction and a spring tensioned actuating pawl on said spark arm adapted to alternately engage projections on said segment to open and close the valve.

496,631. Double Pole Trolley; Thomas E. Adams, Cleveland, O. Application filed June 11, 1889. A trolley shoe constructed with double side walls to form an intervening oil chamber, the inner wall being perforated.

496,636. Method of Anchoring the Ends of Wire; John H. Brown, New York, N. Y. Application filed July 7, 1891. The method of anchoring the end of wire wound up to an abutment, consisting in forcing the wire while held under tension into the gradually contracting space between the abutment and the preceding coil, and subsequently slackening the tension and further forcing a portion of the end of the wire into the contracting space between the abutment and the last coil.

496,648. Magnet Armature; Fred. L. Gregory, Chicago, Ill. Application filed Nov. 16, 1892. The combination with the magnet and its two poles of the curved armature adapted to be pivotally supported at a point beyond and between the poles, and having its pole faces substantially concentric with its pivotal axis, and swinging in proximity to said poles, and having its curvature following the normal line of the greatest magnetic force. (See illustration.)

496,652. Insulator for Telegraph Wires; Ralph G. Hemingray, Covington, Ky., and James C. Gill, Muncie, Ind. Application filed Jan. 3, 1893. An insulator provided with a series of teats at the lower edge of the insulator shield, to attract and gather at their points the drops of water running down the outer surface of the shield.



No. 496,702.—Electric Arc Lamp.

496,658. Galvanic Battery; Frank K. Irving, Brooklyn, N. Y. Application filed Jan. 27, 1892. A plate for a galvanic battery provided with horns extending laterally from one of its faces.

496,659. Hot Box Detector; Robert C. Kerr and Peter Hardman, Fall River, Mass Application filed Nov. 26, 1892. The combination with a journal box, a signal and an electric circuit including the signal, of an expansible circuit closing-medium located in a groove in the under side of the journal box in proximity to the journal on that side of the journal toward which the latter normally presses with the greatest force, and contact pieces located in position to engage the expansible circuit closing medium when the medium reaches a predetermined degree of heat.

496,678. Voltmeter; Arakelyan H. Armen, Lynn, Mass. Application filed Sept. 8, 1892. In a voltmeter, the case having a flat back and bottom and the face plate partially covering the front thereof, in combination with the armature and eccentrically mounted pointer and with the drooping parabolic index or gauge,

496,690. Electric Alarm; Henry F. Kolbe, Detroit, Mich. Application filed Nov. 14, 1892. In an electric alarm, the combination with the vibratory armature, an electric circuit and actuating devices for the armature in one branch of said electric circuit of the apertured arm secured to the armature, the locking latch having the pin and extension and the releasing magnet in a separate branch of the electric circuit.

496,701. Electrode for Arc Lamps; John F. Sanders and Sarah J. Sanders, Portland, Ore. Application filed June 15, 1892. An electric light carbon having a coating of copper and a second coating of an illuminating metal, as magnesium, calcium, antimony or zinc.

496,702. Electric Arc Lamp; John F. and Sarah J. Sanders, Portland, Ore. Application filed June 15, 1892. In an electric lamp, the combination of the frame sides, the tubular casings and the spring armed guide clamps within said casings to hold the adjacent end of the carbons, the sliding holders within said clamps for carrying the carbons, and the springs for forcing said holders toward each other. (See illustration.)

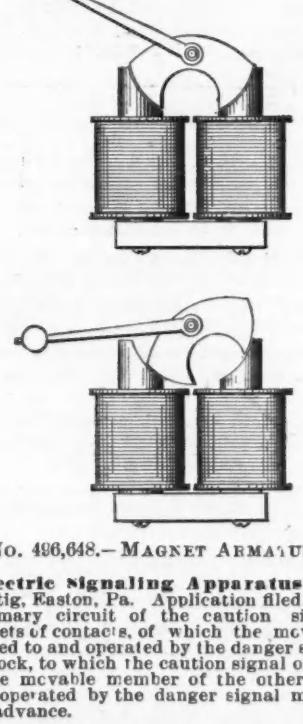
496,724. Burglar and Fire Alarm; Wm. C. Dillman, Brooklyn, N. Y., and George A. Seib, New York, N. Y. Application filed June 11, 1892. A burglar and fire alarm, comprising revolvable make and break wheels adapted to send in dissimilar calls and connected electrically with a central office in the usual way, manually and electrically operated mechanism for tripping and releasing the said wheels, a switch adapted to shift the current from one wheel to another, and automatic mechanism for operating the switch by the movement of the wheels.

496,728. Electric Meter; Joseph Edmondson and Joseph Oulton, Bradford, England. Application filed Sept. 29, 1892. In an electric meter, the combination with a vibrating contact maker, of an impulse arm adapted to impel the said contact maker and make contact therewith, an electromagnet in circuit with said contact maker and impulse arm, and an armature therefor adapted to lift the said impulse arm.

496,743. Element for Galvanic Batteries; Auguste Louis de Meritens, Paris, France. Application filed Sept. 30, 1891. An electric battery having a liquid wholly or mainly of dilute sulphuric acid and a positive pole or lead combined with platinum and presenting leaden and platinum surfaces.

496,746. Correcting Electricity Meters; Joseph Oulton and Joseph Edmondson, Bradford, England. Application filed Sept. 28, 1892. In combination, the main coil carrying the main current, volt coil, correcting coil wound upon or beside same, the latter carrying a portion of the current, fork supporting said volt and correcting coils and pendulum rod.

496,775. Electric Forge; George D. Burton, Boston, Mass., and Edwin E. Angell, Somerville, Mass. Application filed Nov. 18, 1892. An electrode for an electric forge, consisting of a pair of tongs provided with conductive contact rolls, a slide plate for supporting said tongs, and a bed in which said slide plate moves



No. 496,648.—Magnet Armature.

496,786. Electric Signaling Apparatus and System; Jacob W. Lattig, Easton, Pa. Application filed Dec 27, 1892. The grounded primary circuit of the caution signal, completed through two sets of contacts, of which the movable member of one is connected to and operated by the danger signal mechanism of the same block, to which the caution signal of that circuit pertains, and the movable member of the other similarly is connected to and operated by the danger signal mechanism of the block next in advance.

496,787. Electric Signaling Apparatus; Jacob W. Lattig, Easton, Pa. Application filed Jan. 25, 1893. The combination with an electric motor, a signal or other movable body to be operated by the same, and mechanism for imparting motion from the motor to the signal, of a magnetic clutch forming part of said intermediate mechanism, comprising an electromagnet fast to one part of said mechanism, and an armature therefor fast to the other part of said mechanism, movable to and from the magnet, and when attracted and held by its magnet adapted to slip on the pole of the same, whereby after the signal has been moved to and arrested in the desired position, the magnetic clutch, while allowing continued movement of the motor armature, acts as a magnetic brake to gradually arrest the movement of the latter without shock or jar.

496,791. Armature Attachment; Wm. D. Packard, Warren, O. Application filed March 25, 1892. The improvement in dynamos consisting of a sleeve removably secured to the rotary shaft of the dynamo and forming a bearing common to both the armature and commutator.

496,792. Attaching Device for Electric Light Fixtures; George Peeples, Philadelphia, Pa. Application filed Nov. 19, 1892. A plate having converging arms set out therefrom, and a central collar joining said arms, the inner wall of said collar having longitudinally extending recesses, and the back of the same transverse extending recesses, said recesses being at an angle to each other.

496,801. Electrical Testing Outfit for Cables, Etc.; Edward W. Stevenson, New York, N. Y. Application filed Sept. 1, 1892. Electrical testing apparatus, consisting of two independent testing boxes, in combination with a frame to which the said boxes are detachably secured at a distance apart, and a tripod or portable support by which the frame is supported at a distance above the ground.

496,807. Electric Cut-Out; Augustus Wright, Providence, R. I. Application filed Nov. 9, 1892. In an electric cut-out having contacts and means operated by a rotatable shaft for electrically connecting and disconnecting the same, the combination with such shaft and a cross member secured thereto, of a lever and a spring operated roller bearing carried thereby, adapted to bear on said member and to alternately depress the ends of the same to rotate the shaft.

496,808. Electric Switch; Augustus Wright, Providence, R. I. Application filed Nov. 9, 1892. An electric switch having contact posts and arms carried by a rotatable shaft for connecting the posts in pairs, the combination with the shaft and an arm extending at right angles therefrom, of a pivoted lever having a guide-slot, a block sliding in this slot, a link pivotally connecting the block with an arm on the shaft and means for depressing the block.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.